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THE RELATION OF BIOLOGY TO HUMAN WELFARE.[1]

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Twenty years ago, when I began teaching in secondary schools, it was relatively easy to formulate an educational creed. To be orthodox one need only to say, "(1) I believe in the high school teaching that best fits for college, and, (2) I believe that this college preparation can best be secured through the intensive study of Latin, Greek and mathematics."

In recent years, however, to quote from our old-time Latin authors, "tempora mutantur," and with these changes in the times have come astonishing changes in our educational "credos." Greek has practically disappeared from our high school curricula, the study of modern languages has been widely adopted, and the teaching of history and science has been wholly reconstructed.

Heavy demands are made upon the secondary school of today. It must not only prepare the relatively few who are to take a course in a higher institution, but it must also meet successfully the widely varying needs of those who are to take up the vocations of agriculture, of technical and commercial pursuits, of domestic science together with cooking, sewing and millinery. It must care for the physical well-being of the youth, and give attention to the eyes, ears, teeth, heart and lungs. It must give aesthetic training in drawing, music and artistic appreciation. And even moral training in self-control and civic virtue is expected at least as a by-product of high school instruction. The latest demand that seems imminent is that of the teaching of sex hygiene. When all these demands have been met, one cannot help wondering what function is to be left for the modern parent. To be perfectly consistent, should we not add a nursery and an undertaking establishment to our school plant, and then advertise that we fulfill all functions from the cradle to the grave!

[1] Address delivered before the New York State Science Teachers' Association, at Syracuse, N. Y., Dec. 31, 1913.

Speaking seriously, however, there are two articles of my educational creed of which I am becoming increasingly sure. The first is this: Of all American institutions outside the home, the public school has the greatest *possibilities* for contributing to individual and public welfare. In making this rather sweeping statement, I do not forget the work of the church, an institution that should minister to the deepest needs of humanity. Unfortunately, however, all the churches together touch directly probably less than half of the population of our country.

Perhaps you have read Gill and Pinchot's careful study of "The Country Church" in two rural counties, one in New York state, the other in Vermont. "To sum up," the authors say, "while in the twenty years covered by the investigation, membership was making a trifling gain, church attendance was suffering an alarming reduction. In a word, the vitality and power of the country church in these two counties is in decline." It is probably safe to say that a similar conclusion would be reached from a study of a large proportion of rural communities.

In contrast to the church situation, that of the school is most striking. With our American compulsory education law practically every individual spends at least a considerable part of his early life in the school room, and the growth of the public high school in most communities considerably exceeds the increase in population. So much, then, for the far-reaching influence of our public school system.

The second article of my educational creed can be stated as follows: Of all subjects of the high school curriculum, biology may be made the most effective for the welfare of the individual, the community, and the human race. Kindly notice, however, that in my sweeping claims for the subject in which I am so deeply interested, I used the potential mood, not the indicative. For I hope I am the last one to assert that we biology teachers have anything approaching a full vision of the possibilities of our mission, indeed we are far, far from utilizing our present abundant opportunities for useful service.

Let me now, in the time at my disposal, discuss some of the possible relations of biology to human welfare in the three aspects to which I have just referred. First, we may ask: What are some of the ways in which biological teaching may contribute to the welfare of the individual high school student? As a partial answer, at least, may I quote one paragraph from an address given at the Fourth International Congress of School Hygiene at Buffa-

lo last August by Prof. Winslow of the College of the City of New York?

"It is an obvious truism that education is meant to prepare for living; and it seems clear that the most general and fundamental phases of the art of life should receive proportionate representation in the preparatory process. The average man uses his history once a day perhaps, his arithmetic somewhat oftener. Even his English grammar is on trial during a part of his working hours only, and his whole mental equipment is put by for a third of the twenty-four. He is *living* all the time, however, and is either well or ill, happy or miserable, efficient or useless, largely as a result of the conduct and management of the delicate physical machine which is in his charge. He may be innocent of historic fact, of the multiplication table and of syntax, and yet be a useful and contented citizen. He cannot be either long without observing the laws of hygiene and sanitation. I fancy that anyone with a child of his own will have no doubt that knowledge of what to eat and what not to eat and why, of the meaning and importance of fresh air, of the claims of exercise and rest, of the essential routine of body cleanliness, of how germ diseases spread and how they may be controlled, of the methods of rendering water and milk safe and the reasons therefor, of the dangers of insect-borne diseases and of the essentials of public sanitation—these are of even greater moment than those which prepare for the intellectual and social life."

These subjects of which Prof. Winslow speaks are the very topics we are coming to see are of first importance in our courses in biology. The studies of living plants and animals contribute a firm basis of observational and experimental knowledge as to the necessity for food, air, exercise, and rest. These fundamental principles of all healthy organic life, emphasized thus early in the course, should find most practical applications in the life of the boys and girls who are studying the subject.

Let me outline briefly a few of the hygienic lessons we try to emphasize in our first year course in elementary biology. During the study hours of each half year, I try to make some examination of the teeth of each student in my official class, and the results show that even among our high school boys and girls there is sad need of dental work. To the parent of each student who had imperfect teeth, we sent a statement like the following:

The Morris High School, December 12, 1912.

My Dear Mr. ....:

An examination of your .... teeth shows that at least

. . . . cavities need to be filled. As you doubtless know decaying teeth are always unsightly, they are frequently the cause of ill-smelling breath and of indigestion, and unless they are treated promptly the decay inevitably results in pain and in final loss of the teeth. It has been found by careful experiment that false teeth have only about one-fifth the grinding power of a natural set.

It is, of course, important that work on the teeth be done by a competent dentist. The following public institutions in the Bronx have lists of such dentists: Lebanon Hospital, Westchester Avenue; Bronx Eye and Ear Infirmary, 404 E. 142; Eye, Nose, and Throat Clinic, 580 E. 169. If I can be of any further service to you in remedying these defects, kindly write or come to see me. Please sign below and return this slip, that I may know you have seen this statement.

Very truly yours,

. . . .

Signature of Parent . . . .

Before the close of the term, each student is asked to state whether or not the needed work has been done. The results in many cases have been very encouraging.

One of our teachers, Miss Edith Read, with the assistance of physicians has prepared the following careful list of indications of poor physical condition, which may help any observant teacher to detect adenoids and enlarged tonsils, defective eyes and ears, spinal curvature, and heart and lung difficulties. A directory of New York hospitals and dispensaries where treatment can be had is also appended.

Eyes.

Poor vision (i. e., book held six inches away in near sight, or perhaps two feet away in far sight).

Redness or discharge of eyes.

Heavy eyes.

Bulging eye-ball accompanied by undue fullness of neck. (Exophthalmic goitre.)

Peculiar misspelling of words—transposing of syllables, etc.

Ears.

Cotton worn in ears.

Discharge from ears.

Habitual misunderstanding of questions.

Adenoids and Tonsils.

Inability to breathe through the nose.

Habitual colds and frequent nose bleeds.

Poor articulation (as if the child had a cold in the head).
A narrow upper jaw and irregular crowding of the teeth.
Deafness.
Chorea or nervousness.
Bad breath.

Teeth.

Habitual bad breath.
Visible decayed spots.
Toothache.
Vertical or horizontal ridges in teeth (notched edges) indicates malnutrition.

Spinal Curvature.

One shoulder higher than the other.
Crooked position when walking.
Crooked position when writing.

Heart and Anaemia.

Pallor.
Undue shortness of breath and blue lips after exertion. (Note condition after fire drill or after coming up from basement.)
Marked pulsation in vessels of neck.

Lungs.

Persistent cough.

LIST OF HOSPITALS AND DISPENSARIES.

Fordham, S. Boulevard, cor. Cambreling Ave.
Harlem, Eye, Ear, and Throat Infirmary, 144 E. 127th Street.
Board of Health Hospital for Contagious Eye Diseases, 341 Pleasant Ave.
Lebanon, Westchester Ave., near Cauldwell Ave.
Manhattan Eye, Ear and Throat, 64th St., near Third Ave.
New York Eye Infirmary, 218 2nd Ave.
New York Ophthalmic and Aural Institute, 46 East 12 St.
New York Ophthalmic, 201 East 23d St.
New York College of Dentistry, 225 East 23d.

In connection with the study of foods each student is asked to state as accurately as possible the kinds and quantities of foods and beverages he had at each of the three meals of the preceding day. In discussing these menus we have abundant opportunity to call attention to faulty diet, and to give many suggestions for a more economical and efficient supply of food.

The wide use of tea and coffee among young people is a con-

stant source of surprise. In many cases, however, we have been assured that as a result of the biological instruction, the use of these stimulants has been discontinued. We try, too, to make our teaching relative to alcohol and tobacco sane and effective by emphasizing the striking difference in the effect of these substances—tobacco especially—on the boy and on his father. The economic and social aspects of the liquor problem are also dwelt upon as a deterrent from any use of alcohol.

One among many of our interesting conferences with individual students outside the class room may be referred to. The boy was a Russian Jew, but he did not know his age, or much about his parents. He roomed far down on the East Side of the city in a janitor's apartment. He arose at five o'clock each morning for study, and his breakfast consisted largely of strong tea. After his long trip up town and the hours in school, he returned to the vicinity of his room and taught Hebrew till late in the evening. It was not difficult to convince the boy that if he hoped to realize his ambition of a college and law school course, he must have less stimulant and more food and sleep. The change in the youth after he adopted these suggestions was most striking. If time permitted I should like to tell of many other ways in which our biology teachers have come into close touch with individual students and their parents, and have been able to give them help in matters relating to home ventilation, treatment of wounds, care of the eyes and ears, and to help them to acquire better habits of exercise, study and rest.

One of the most interesting and profitable topics in the whole course is that of bacteria and sanitation. The omnipresence of germs in air, water, food, milk and on the exterior and even in the interior of the body is easily and convincingly demonstrated in any school by exposure of the Petri dishes containing nutrient agar. The favorable conditions for the growth of these organisms are then determined experimentally, and various methods of killing them are shown. It is most important in this study to teach boys and girls the absolute dependence of agriculture and of many industrial processes upon the action of bacteria, as well as to discuss the harm done by these germs in causing disease. Several weeks are devoted to the application to human welfare of these experimental studies, and among the topics that should, undoubtedly, be considered in almost every community are these: clean water and milk supply; care of food in the market and the home; disposal of household wastes; proper methods of sweeping and

dusting; cause and prevention of tuberculosis, diphtheria, typhoid fever and malaria; quarantine; disinfection; work of the Board of Health.

It is evident that much of the discussion on the topic "Bacteria and Sanitation" has to do with the welfare not only of the individual but of the community as well, and so, in the second place, let us see how biology may further contribute to general civic welfare. If a youth learns in his biological study some of the ways in which the acts of the individual inevitably react for the good or ill of the community, is he not more likely to coöperate with the organized forces of government, not only for the promotion of health, but also for the conservation of our natural resources? Surely, if we are to save the remnant of our forests and of our insect destroying birds, we must insist that the voters of the future whom we are now training shall realize the tremendous importance of these possessions; and how can this knowledge be imparted more effectively than in biology courses.

Pests like flies and mosquitoes, codling and brown tail moths can only be exterminated by an aroused community action, and such action is of course necessary to secure public utilities like a pure water supply or an efficient sewerage system. What subject in the high school curriculum is better adapted than biology for promoting intelligent civic action along these many lines?

And, finally, we wish to make the claim that no subject is better adapted than biology to give some of the instruction that is sorely needed if the human race is to escape threatened degeneration. I do not wish to be regarded as an alarmist, but I believe the majority of my hearers will agree to each of the eight propositions to which I now ask your attention—propositions to which Dr. Charles W. Eliot, President of the American Federation for Sex Hygiene, has given his hearty approval.

1. The normal child seeks to know the source of his being and naturally questions his father or mother.

2. The average parent either silences all questions relating to these topics, or shuffles in his answers. Seldom does the child get any satisfaction from this source.

3. The child, therefore, turns to other sources of information, and two unfortunate results follow. First, much of the information he gets is untrue; and, secondly, the parent loses a great opportunity to keep in sympathetic touch with the problems of his child.

4. Some of the reasons for this "conspiracy of silence" on the

part of the parents are his ignorance of the essential facts of plant, animal, and human reproduction, and his utter incapacity to explain this process without embarrassment because of the lack of a wholesome vocabulary.

5. Both of these needs of the parent of tomorrow should be supplied by the courses in biology which treat of the function of reproduction as a universal and beneficent process of all living things. And we might add that biology is the only subject in which these facts can be presented in a normal way.

6. Not only does the child need to know in clean and wholesome terms the essential facts of reproduction, but even more through the days of youth does he need parental counsel. It is during these days that self abuse becomes very prevalent among youths. At this period, too, the mother should give wise counsel to the daughter relative to the periodic physiological experiences that are to occur, and the father should prepare the boy for the corresponding experiences of seminal emissions which often frighten youths and not infrequently drive them to quack doctors. The boy should, of course, be taught that these emissions, unless they occur several times a week, are perfectly normal and cause no harm.

7. The fearful prevalence of syphilis and gonorrhea is becoming an increasing peril of our civilization. Gonorrhea is said by eminent physicians to be a frequent cause of sterility in marriage and to be the direct cause of many operations among women. Most of the cases of blindness of the new born are due to this cause. Of syphilis and its attendant woes, too black a picture cannot be painted. Yet the average parent gives no warning of the peril of these diseases to either son or daughter. Even among the picked young men who enter college, sexual immorality, with its constant danger of infection, is surprisingly common.

8. It is therefore evident that in every community the teacher, the physician and the clergy should do all in their power to arouse the parents of today to some sense of responsibility in these matters. This may be done by talks with individual parents, by small conferences of interested fathers or mothers and by a distribution among parents of carefully selected books or pamphlets in which the facts are presented in a simple but thoroughly scientific way. *Until, however, we know better than we do now how it should be done, it would seem to be extremely unwise to introduce any wholesale sex instruction into the public schools.*

Have we claimed too much for the possible benefits that may

be expected from biological instruction? No one knows better than one who has been seeking the light for more than twenty years, that to attain even a fractional part of this individual and community enlightenment we must have well trained and enthusiastic teachers of biology—teachers who not only are familiar with subject matter, but even more important, those who are in sympathetic touch with child life. In the end this means that communities must be aroused to pay better salaries and to insure more certain tenure of office. For who can expect a teacher to attack courageously local problems of health and betterment only to lose his official head?

For the supply of teachers which we sorely need, we look to our colleges and universities. In preparing for this address, I sent out a series of questions to the professors of biology in twenty of the higher institutions of New York and New England. Every one to whom I sent the questions was kind enough to return a prompt and detailed reply as to the courses in biology now given. Only two or three of these institutions make any claim of directly preparing teachers for secondary school work and so far as I can gather the courses now given in our colleges and universities are presented almost wholly from the standpoint of pure science, not from that of the relation of biology to human welfare. No one can doubt that the morphological and physiological aspects of the subject are being admirably taught. But lest it be thought that I am alone in my belief that most of these higher biological courses are neglecting some of the great calls for civic usefulness, I beg leave to quote from a recent book on "Our Vanishing Wild Life," by Dr. W. T. Hornaday of the New York Zoölogical Park. Dr. Hornaday, as perhaps you know, like a modern Crusader, led the victorious campaign that resulted in the passage by the New York legislature of the Bayne-Blauvelt bill, prohibiting the sale of all native wild game throughout the state of New York; and it was largely due to this same tireless worker that the new Tariff Law has incorporated in it the provision to exclude from the country the feathers of all wild birds. Listen to what this leader in the conservation movement has to say relative to the failure of some of our leading institutions of learning to coöperate in this great work.

"Columbia University, of New York, has a very large and strong corps of zoölogical professors in its department of biology. No living organism is too small or too worthless to be studied by high-grade men; but does any man of Columbia ever raise

his voice, actively and determinedly, for the preservation of our fauna, or any other fauna? Columbia should give the services of one man wholly to the cause.

"There are men whose zoölogical ideals soar so high that they cannot see the slaughter of wild creatures that is so furiously proceeding on the surface of this blood-stained earth. We don't want to hear about the 'behaviour' of protozoans while our best song birds are being exterminated by negroes and poor whites. . . .

"*The University of Chicago* should become the center of a great new protectionist movement which should cover the whole middle West area, from the plains to Pittsburgh. This is the inflexible logical necessity of the hour. *Either protect zoölogy, or else for very shame give up teaching it.*

"*Every higher institution of learning in America now has a duty in this matter.* Times have changed. Things are not as they were thirty years ago. To allow a great and valuable wild fauna to be destroyed and wasted is a crime against both the present and the future. If we mean to be good citizens we cannot shirk the duty to conserve. We are trustees of the inheritance of future generations, and we have no right to squander that inheritance. If we fail of our plain duty, the scorn of future generations surely will be our portion."

One of my college correspondents, however, would doubtless disagree entirely with Dr. Hornaday's position, for he says: "I seriously fear there is danger of losing sight of what I regard as the primary aim of school work, namely, training and development of mental power, capacity to grasp a problem and ability to proceed intelligently toward its solution. Now, much of the so-called 'practical' and 'vocational' and informational subjects just now so much in vogue, it seems to me, either ignore the aim just cited or largely miss it. . . . Latin, mathematics, etc., may have too long been dominant in our educational programs, I am free to admit; but the other extreme to which things have been driven of late is quite as dangerous in my opinion." Is it true, then, that we are emphasizing too strongly the relations of biological teaching to human welfare? In reality can we secure the desired mental training and the capacity to solve problems just as well by utilizing some of the material we have suggested as by engaging in the more orthodox morphological and physiological studies?

All of my hearers will, I am confident, agree with another of

my college friends when he says: "The best training for a teacher, I believe, is to work under the direction of a good teacher." Is it not a bit unfortunate then for our future high school teachers that so many of our splendid biological leaders are so deeply engrossed in research work that they have little time or enthusiasm for teaching? To quote from Dr. A. J. Goldfarb's suggestive article on "The Teaching of College Biology" in a recent number of *Science:* "As a rule, college teachers are not expected to annoy themselves with principles of education or with methods of teaching. To do so is to ally oneself with prep. school ideas and associations. To be in open sympathy with any effort to arouse interest in the teaching side of one's profession is to lose caste with one's colleagues. Though primarily employed to teach, the consideration of one's specialty from the teaching standpoint is to be considered a necessary evil to be tolerated but not encouraged." If such be really the attitude of our higher institutions, our high school biological departments must wait long before they will have a better corps of teachers, or we must look to other sources for the training that is needed.

There are many signs of the times on the biological horizon that should encourage us greatly. This subject has certainly ceased to be regarded as a "fad" or a "frill" in our New York educational scheme, if we may judge by the increasing numbers each year of those taking the elementary and advanced courses. The National Education Association also has just recently recognized the worth of biology by appointing a committee of seventeen of which the speaker has the honcr to be chairman. Leading college and secondary school teachers of biology throughout the country have consented to coöperate in the work of this committee in suggesting improvements in the aims and methods of teaching biology. Our committee is now preparing a circular which we are to send out widely in the hope of securing constructive criticisms and suggestions. When this circular reaches your school, we bespeak your cordial assistance.

In view, then, of our widening opportunities as biology teachers, shall we not each one of us make a deeper study of the needs of the various communities in which we work, and enter courageously upon each line of work that promises to contribute to the individual, civic, and racial welfare of our times?

ARITHMETIC AND SAVINGS.[1]

By Frederick L. Lipman,

Vice President, Wells Fargo Nevada National Bank, San Francisco, Cal.

The elements of arithmetic are so simple, the axioms relative to savings are so trite that it would seem idle to attempt to say anything worth while about either. Yet observation shows that most of us fall far short of the ideal in the handling of our financial affairs. Our theories are indeed correct enough; it is practice wherein we fail. The thesis of this paper is that a means may be found to enable us more fully to bring our practice up to theory through an adaptation of business arithmetic.

Our old friend Micawber was strong in his knowledge of the theory. "Annual income twenty pounds, annual expenditure nineteen nineteen-six, result happiness. Annual income twenty pounds, annual expenditure twenty aught and six, result misery."

If the man from Mars should visit us he would find that on the whole there was apportioned to each of us a share of the social income roughly approximating our contribution thereto. He would be likely therefore to infer that every man would regulate his consumption in accordance with his means, would foresee the future and provide out of his current earnings for that future, but he would be egregiously mistaken. The number of people who intelligently direct their financial affairs is so small that we are warranted in the conclusion that, as a people, we are shiftless and improvident. The fault lies rather in a lack of thought than in a want of knowledge; but we are willing to do almost anything rather than think, and so our money affairs drive us. On the side of income we are apt to strain every effort, to think and to strive; to progress in our callings and professions. But on the side of expenditure we drift along into self-indulgences, and blind ourselves to the need of provision for the future; in a word, we refuse to give constructive thought to the subject.

We can afford something more than mere subsistence day by day. There is therefore a surplus, however small, to be apportioned in accordance with the best interests of the individual; and to do this aright is, or should be, his problem. He is likely, however, to remain oblivious of the longer views of life. These latter should remind him that the earnings of a lifetime must meet

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[1] Presented before the Mathematics Section of the California High School Teachers Association at its summer conference in Berkeley, July, 1913.

the expenses of a lifetime. The income received in time of health must cover days of sickness; that during the strength of youth he must also care for old age and decay. Most of us harbor a sufficient pride if we can boast that we keep out of debt, if we do not spend more than the day's income; and therefore the slightest misfortune is likely to find us unprepared and without protection. Then we bewail the ways of an inscrutable Providence instead of putting the blame where it belongs, upon ourselves. We quote the maxim, "Save the pennies and the pounds will take care of themselves," and then feel contempt for the effort necessary to avoid the useless expenditure of small amounts.

Where should one look today for carefulness in trifling expenditure, say that of a five-cent piece? Not among the poor, not among those of us in moderate circumstances; we should probably feel above bothering with anything so small. Such care would be found in the great corporation which, without sentiment but with a sure business instinct, turns its face against waste. As individuals we spend on impulse, thoughtlessly. We think we have done well if we have withheld from a particular expenditure long enough to say to ourselves, "Do I want this article more than I want its cost?" when the question really is, "Is the expenditure a proper one, *all things considered?*" We say, "I think I am entitled to this luxury," when in fact we may have already spent all and more than all, that could fairly be apportioned to luxuries.

In seeking a remedy, we naturally cannot expect to provide some panacea which would remove at once and forever all our financial ills. Real misfortunes will arise from time to time to plague and vex us. But we can and ought to expect ourselves to use some judgment in this important department of our lives; and to use judgment we must know the facts, and the latter must be recorded and presented in an intelligible form, simplifying complex details so that they may be fully grasped and their significance appreciated. And this involves the keeping of accurate accounts of income and expenditure, all items being properly stated, balances being struck at short intervals and expenditures tabulated for the purpose of study and criticism. Without desiring to claim too much, it is evident that such accounting would put one a long step forward on the road of obtaining control of his affairs, of eliminating useless expense, of handling his income with that care which its importance demands.

Look at the great corporations and observe how carefully they

aim to keep account of every item relating to their affairs. Plainly enough no business can be successful unless its operations are governed by a wise intelligence, and this intelligence must make itself acquainted with the facts and conditions just as they are, and hence there must be kept painstaking records showing every detail.

And what is necessary for a large business enterprise is relatively so for a small one, for a household, for an individual. Efficiency in the material affairs of the household or the individual, requires that, at the conclusion of the year after making all allowance for loss and depreciation, a real net profit will remain to be saved and carried forward to the next period.

Among the men who do look carefully after this in their business, how many there are who neglect it in their private affairs? They seem to think that because business is the place to earn and save money and home the place to spend it, nothing business-like should be expected in the home, especially nothing so tiring and irksome as keeping accounts.

Many men take some amount of care in their expenditure; they even allow themselves to be irritated over the size of the family bills at home; from time to time they warn themselves and their families that this sort of thing must stop. But they are shiftless, they do not bother to regulate their private and home expenditure in a systematic way, they refuse to face the facts.

And so, among us all, whatever our activities or the extent of our incomes or possessions, there is this need for the organization of expenditure and for keeping records and accounts, that we may know where we stand and in what direction we are moving. We could hardly keep a record of income and outgo without being impressed with the need of net income, without being reminded that our present income is secure while that of the future is uncertain; that our earning capacity is now intact, but we cannot be sure that will be the case tomorrow. With these considerations constantly suggested to one's mind, it is evident that such accounting would tend to make one put his principles into practice.

The character of the accounts to be kept is very simple, requiring no more than the mere elements of arithmetic. The accounts should always be accurate, should include all items, should be balanced, and the different categories of expense should be classified. This may sound formidable and complicated; but it is not so; it is more or less of a bother; it is rather irksome; it is easier to begin than to keep up; but if one will do it and persist in it,

it may become a valuable habit. As a habit to be acquired it should be begun if possible in childhood. In the schoolroom, if even a few in a class will gain a facility in this practical application of arithmetic and acquire the habit of keeping their own personal accounts, though it may be nickels and dimes at the start, a great good will be gained.

Now what shall we do with our savings when we have accumulated them? In what shall we invest? To this question there is no general answer, but there are certain principles of investment which may be deduced from experience.

First. Before making investments, strictly so-called, one should provide for regular foreseen future contingencies. Suitable insurance against death, fire and accident should be the first care.

Second. The main quality to be sought in an investment is security, and to this everything else should, as far as need be, be sacrificed. To keep one's property safe for his future benefit is indeed the underlying purpose of an investment.

Third. One should therefore avoid any attempt to make money through investments. The main purpose being to protect the principal unimpaired, any income that may be derived is just so much to the good; attempting to increase the profits beyond what is normal for safe investments leads to speculation; indulgence in speculation makes the loss of the principal probable and in the long run almost certain.

Fourth. Safety demands, not merely that the amount invested shall be ultimately repaid, but that it shall possess a satisfactory degree of convertibility. If as an individual I lend money to be returned in ten years, I have made a contract extending beyond the reasonable limit of human foresight. How do I know what needs may arise within ten years? Even in life insurance—essentially a long-time contract—provision is now made whereby the insured may withdraw some part of his payments in the shape of a loan on his policy.

When some one brings us a glowing opportunity for an investment, we may ask ourselves, "Is it a scheme to make money? Is it safe? When may I expect returns? Is it a speculation?" Opportunities of the "glowing" kind are generally open to criticism along some one or more of these lines. If, however, it seems conservative and convertible enough, we should then avoid putting in an amount that would be large for the individual. Still more should we avoid the foolish temptation that sometimes comes to one of borrowing money to

invest. This is such a stupid thing to do, that one wonders that so many people commit the blunder. A person may borrow money to carry on his business or to build his house or for some temporary need. But if we understand investment aright, that it is not a scheme for making money, but merely one for getting a safe return on saved funds, it will be seen how absurd it is to involve one's self in the hazard of borrowing money in order to invest more largely than one's own funds would warrant.

Moderate returns are inseparable from safety. The prevailing interest rates on safe investments may be $3\frac{1}{2}$ per cent or 4 per cent or 5 per cent; but whatever it is, no sound investment at the time can pay more. If it does promise to do so, it is either because it is making a promise that will not be kept, or because the higher return is of the nature of an insurance premium on some known or unknown hazard. In the present condition of the money market safe investments will pay say 5 per cent. If an opportunity is offered one which will give him 6 per cent or 7 per cent or higher, he should scrutinize it carefully and obtain expert advice before parting with his funds. And that brings us to another principle. While a person must in the last analysis use his own judgment, he should not depend entirely upon that judgment. Here it may be said that it is easy to commit a blunder in the direction of assuming one's self to be sufficiently informed, when in fact he knows practically nothing of the matter. Professional and other non-business people seem to be particularly prone to this error; they often think themselves informed because the advertisement says so, and still more do they feel confidence if some friend has told them about it.

The fact really is that good faith seems to be less scarce than good judgment. People engaged in selling investments, often feel a very imperfect sense of responsibility in recommending them. In fact, it is generally safe to mistrust investments that are offered to one. The best and most conservative opportunities do not approach one in this way, their net return being too small to bear the expense of salesmanship.

A legitimate prospect of a good investment does not need to be hawked about looking for small amounts of individual funds. There is nearly always capital to be had from wealthy investors, men who are experienced and shrewd, looking constantly for a safe outlet for the use of their funds. Theirs is the regular supply of capital for legitimate enterprises, because such men are

in a position to measure the degree of risk and to fortify themselves against it.

One's own judgment is an insufficient guide in passing upon the merit of the representations so made in order to sell securities. We should take no chances. The country is full of those who have earned through hard work and saved through great sacrifice and then have lost their means through poor investments. We all know such cases. Most of us have had such experiences. Let us be satisfied with a small return so long as we have reason to know that our capital is absolutely safe.

If a man is to be prosperous he will save out of the stream of his income something to protect the future of himself and his family. The few have always realized the importance of accumulating. More and more will it be necessary that this knowledge and the consequent responsibility should be brought home to all. It is not to be expected that every one can become an expert on investments any more than on questions of law, but any man, whoever he may be, whatever his calling or responsibilities, ought to know enough about law to realize when it is expedient for him to call in a lawyer, and sufficient investment theory to know when to consult an expert.

How much of all this may be taught the young? I do not know. But it would seem that the basic principles of saving, accounting and investment might be codified and simplified and taught to boys and girls before they leave school; that is to say, before they pass beyond the influence of public instruction.

If the coming generations are to be guarded against the inheritance of our shiftlessness, if they are to be taught the importance of correct practice in their material affairs as a basis for the higher things of life, and if proper habits are to be acquired, it will be while they are young and continue subject to the influence of parents and teachers. But after all the main deficiency is not concerning principles and theories, but concerning practice, and so it seems to me that the most lasting good is to be expected from training, from actual practice along lines of approved theory, of which the effort to give the children definite work in accounting as an exercise in arithmetic, is an excellent example.

THE TWO YEAR VOCATIONAL COURSE IN ELECTRICITY AT THE ENGLEWOOD CHICAGO HIGH SCHOOL.[1]

By Walter R. Ahrens.

In September of the year 1910 the Board of Education introduced into the Englewood High School a two year course in Electricity. In the fall of the following year, October, 1911, I was given the task of organizing the course in electricity at this center and had also, to fill my program, several classes in physics. The electrical classes since the subject was new and no equipment had been provided, had to be run with the equipment used in the regular physics work. This unfortunate situation complicated matters for me very materially. The success of the course, if I may call it a success, is therefore due largely to the generosity and willingness to help of Mr. Tower, head of the department of physics. Since the physics department equipment was the only available, I had to arrange the course so as to fit in with it rather than arrange a course and get the necessary equipment. The work as carried on was about as follows. The two years' work is divided into four semesters, each semester's work depending more or less upon the work of the previous one, thus making it a progressive course. However, my plan has been, as will be seen, to make each and every semester one which will give the student a complete knowledge of a certain phase of the electrical work with more or less elimination of all other phases of the subject, and still enough enlightenment of them, so that when reached they are not entirely a mystery.

The four semesters are designated as follows: 1B, 1A, 2B, and 2A electricity. The figures indicate the year and the letters denote whether the work is beginning or advanced.

The first semester the student is required to take physics, (mechanics and heat) having two recitations and three laboratory periods. In presenting this work I try to take up, as far as possible, only such questions as apply directly to the electrical line. A glance at the list of experiments which I have chosen will illustrate this point.

(1.) Practice with the metric system. This experiment will form the basis of wire measurements and motor calculations the next year.

(2.) To find the value of pi and the volume of a cylinder. This

[1] Read before Physics Section of Central Association of Science and Mathematics Teachers at Des Moines, Dec. 1, 1913.

experiment will serve very materially in the calculation of the volume of a great number of motor parts, as many of them are cylinders.

A few other experiments used are:

Law of the simple lever.

Archimedes Principle.

Density of various solids. After using this experiment in the regular way, instead of actually finding the density, I have the student find the weight by determining the volume and using the known density, since in practice we are after weights rather than densities.

Still another is the Jolly Balance. This takes up the question of springs, which are dealt with in a general way showing how they are used in operating electrical devices such as motor brushes and circuit breakers.

The questions of strengths of materials, work and energy, and friction, are discussed in a general way, yet as fully as time will permit. The experiment "To test the power of a motor" takes into account a few of the last topics mentioned. Following this work I take up the mechanics of fluids, using the force and lift pump and emphasizing the value of water pressure. I also mention centrifugal pumps, fans and propellers.

To complete this much work requires about seventeen weeks. The following two weeks are devoted to the subject of heat, taking up the question of expansion, change of state, radiation, and conduction. All of these are applied as far as possible to the electrical line.

Short tests are given from time to time throughout the semester. In fact I give a ten minute test at the beginning of each recitation having the papers graded by the pupils themselves, each pupil having exchanged his paper for that of another. The directions for the experiments are mimeographed and remain in the laboratory. I use Mann & Twiss as a text, have two recitations and three laboratory periods a week, and complete approximately twenty experiments. The last week of each semester is devoted to general review and the final examination. For the examinations each student is given a mimeographed set of questions. With this method there are no misinterpretations of questions and the examinations can be carried out at any place in the building and can be supervised by an outsider if necessary.

The second semester of the first year takes up electricity and

magnetism. The student now reports ten hours per week instead of the five as in the previous semester. Two of these are spent in the lecture room, five in applied electricity, and three in regular laboratory work. By laboratory work I mean that the student discovers and tests by use of proper apparatus the laws of electricity and works experiments such as are given in the regular physics work. A mention of a few experiments will be self explanatory.

To ascertain what substances are magnetic.
Polarity and magnetic strength.
Effect of breaking a magnet.
To study the magnetoscope.
The simple voltaic cell.
Effect of varying battery resistance.
Electrolysis.
Helices.
Induced currents.
The St. Louis motor.
The electric bell and telegraph.

During this semester twenty-five simple yet weighty experiments are performed. So far only one half of the time assigned is accounted for. The remaining five hours are spent in what I have termed the construction laboratory on applied electricity. Here the student works out practical problems in bell wiring, cleat work, and switch board wiring. All work is actually carried out by the student and all work is confined to bends, joints, and crossings. In fact all the difficult parts of construction work are assigned omitting the straight runs as far as possible so that the student becomes skilled in making soldered joints and splices. The problems for solution are given out in blue print form. This is done so that the student learns how to read blue prints, because that is what will have to be done in practical work. During this time twenty problems are solved. I plan to give each student a certain amount of special work. By special work I mean odd jobs which are rather numerous in any laboratory. I do this for two reasons. First, because it relieves the monotony of the regular work, and in the second place only a certain number are working on the same construction at any one time. This makes the work more or less individual, so that the ideas of one cannot be taken by others and it also cuts the equipment down to a minimum value. We have now arrived at the end of the

first year's work. The student having a note book containing in all forty-five regular experiments and about twenty construction experiments.

Thinking that a brief description of the construction laboratory might be of interest to some I have included it in this paper.

THE CONSTRUCTION LABORATORY.

The construction laboratory is a room in the basement of the building about thirty-eight feet long and twenty feet wide. Twenty-four booths have been erected of cheap lumber as is shown in the sketch. Each booth has a front or working wall which is four feet wide and extends to a height of six feet above the floor. Across this wall and thirty inches from the floor is a shelf, one foot wide, on which may be placed the working materials. Underneath this shelf are four drawers fitted with hasps. Each student is assigned one of these drawers and provides his own lock and key. The booths are three feet deep. This gives a working surface of fifty square feet per booth. To provide light for night classes or dark days each booth has been fitted with an incandescent lamp suspended from a drop cord. To supply each booth with current I have run a conduit line along the top of each section, bringing out leads terminating in two binding posts at each individual place. At the end of each section I have a small switch board, which enables me to supply the students with the regular 110 volt lighting current or by means of a small transformer a 6 volt current for operating bells. In one corner of the room is built a small case in which are placed the supplies. There is also a work bench fitted with both a machinist's vise and a pipe vise.

THE SECOND YEAR'S WORK.

The second year's work is quite different from the first, being entirely electrical and advanced. The text used in the recitation room is Jackson and Jackson. This text is, as far as I can see, the best adopted for the advanced work. However it is necessary for the instructor to use a little judgment in making the assignments. For instance Chapters 21-22-23, which take up the general methods used in testing and apply electricity to the commercial world, could not be left to the last few days or week of a semester and then be given as an assignment. They must be fed in with the regular work from time to time. Then again the chapter headed "Alternating Currents and Machinery," which takes up the construction of the alternating current and power waves, is very difficult for the student and requires more time than the others. In order to make this chapter mean something to the

student I have a number of curves plotted from actual tests on machines used in the laboratory, and have them indicate on them such points as phase difference, cycles, maximum and effective values of currents and power.

The laboratory work of this year is carried on entirely in the testing laboratory. I follow no regular manual but have devised a series of about twenty-five experiments which are purely of the testing nature. Some of those included in the list are:

Circular mil equivalents.

Field tracing.
Copper voltameter.
Wheatstone bridge.
Resistance by Volt-meter Ammeter method.
Motor investigation.
Armature winding.
Transformer calculations.

The student also makes actual tests of commercial articles such as arc lamps, dynamos and motors of all types, mercury arc rectifier, and transformers. These tests are carried out under my personal supervision and in some cases the tests are performed as class experiments. The experiments thus outlined do not take up the assigned time. The student therefore is allowed to manufacture some electrical device which will be of some benefit in the home, such as toasters, bell ringing transformers, or small motors. Besides these articles there are a great many others such as wireless outfits and telephone sets.

Last year's class was very fortunate in that it received about as practical construction work as is possible to get. I received an appropriation which enabled me to purchase six switch boards, a mercury arc rectifier, and eight motors of various types. This apparatus was installed by the students according to my instructions, laying all conduit, pulling all wires, making all joints, mounting all lamp banks, circuit breakers, and transformers. The work was something which every class cannot have and was a very good test of the ability of those undertaking it.

A PLEA FOR MORE EFFECTIVE SCIENCE TEACHING.

By Floyd L. Darrow,
Polytechnic Preparatory School, Brooklyn, N. Y.

The *Normal School Quarterly* for October last contains a discussion by Fred D. Barber on "The Physical Sciences in Our Public Schools" which, by means of government statistics, tends to show that the teaching of these subjects is on the decline, especially in the high schools. That this should apparently be true, notwithstanding the prodigious strides which the application of scientific principles is making in all the activities of modern life, is a fact of which every teacher of these subjects should take note. While all the causes which underlie this situation may be difficult to determine, yet there is one widely prevalent condition which I am convinced results in an enormous dissipation of the pupil's interest, energy and accomplishment. I refer to the kind of laboratory experiments, especially in physics, which are required of pupils, and the toy apparatus with which they are performed.

If the study of science subjects on the part of the pupil is to be anything more than a perfunctory task, he must be impressed with their importance and immense practical significance. This cannot be accomplished, however, by merely talking about the application of scientific principles to everyday life or by performing simple experiments and demonstrations with such totally inadequate and miniature apparatus as to provoke a smile at their exhibition. The pupil must feel that the problem set him is worth his while to do, and to do well. It must command his respect. In order to be able to present work which will enlist the keen interest and serious consideration of the pupil there should be separate classes for boys and girls. Unfortunately this is frequently impossible.

Although I shall deal principally with the teaching of physics, yet the application may be made to any other science subject. First, let me say that the pupil's interest will be aroused only by making him feel that the problem which he has in hand is a real, live proposition. To illustrate, let us take the parallelogram of forces. As this is usually taught, spring balances registering a kilogram, and more often less, are used and the pupil learns by plotting to scale that the diagonal of the parallelogram is equal in the chosen unit to the reading of the third balance. This is all right but the trouble lies in the fact that the laboratory work and demonstrations frequently end there. To make this principle real to the pupil, it should be followed up immediately with work on a roof truss

and a derrick involving weights of from at least 75 pounds to 200 pounds. In the case of the roof truss, it may be shown that the greater the angle of the roof, the greater the horizontal thrust and with a good piece of apparatus the calculated and actual thrusts will come surprisingly close together. A derrick combining the pulley with the resolution of forces and capable of lifting 500 pounds affords a most interesting series of problems. Some work of this kind will drive home the parallelogram of forces and its practical applications as nothing else could. And pupils will work with an interest and intensity hitherto unknown.

Again, in teaching the principle of moments, why put before pupils apparatus calling for the use of only a few ounces or grams, and not taking into account the weight of the bar? It costs but little more to get a piece of apparatus with knife edge supports and a capacity of 100 pounds. The calculated and the actual results, too, with such a lever will come extremely close. With it, each class of lever and the equilibrium of several parallel forces in a plane may be demonstrated. Instead of giving the pupil problems on the lever from a book, make the problems for him, and let him verify his answers for himself. Then the problem becomes a live one, and not a dead one. In the case of the pulley, too, pulley blocks capable of lifting at least 100 pounds should be used and their efficiency determined. A differential pulley hoist of the commercial type will add very much to the pupil's practical appreciation of the mechanical advantages of machines.

In taking up energy, work and power, would it not make the subject a very real one if a one horse power gas engine, connected up with a dynamo, were put before the class and the various transformations of energy traced? Then a problem which makes a very strong appeal is the determination of the horse power of the engine and this problem is not at all difficult. It is one which I do with the members of my general science class. If an observation gas meter is at hand, and the gas company will usually give one to the school, the number of cubic feet of gas necessary to run the engine for a given period may be measured and the cost per horse power determined. By means of a voltmeter and ammeter, the power delivered by the dynamo may be obtained and the efficiency of the engine determined. Now these are problems which arouse the keenest interest on the part of pupils for they feel that they are dealing with real problems.

An experiment which is frequently performed and with very little practical significance, is that of determining the breaking

strength of a wire. But if this were followed up by requiring the pupil to calculate the size of wire necessary to act as a stay-wire for the derrick, when bearing a load of several hundred pounds, the experiment would be well worth while. In the study of heat, we ask pupils to determine the specific heat of lead or some other metal. But why not provide a Parr calorimeter of the commercial type, and have them determine the heat value of various samples of coal? If it is impracticable for all of the pupils to do this individually or by working in pairs, let it be given as a demonstration. To my mind, such a demonstration, when properly written up and understood by the pupil, has far more value than several of the usual experiments and ought to be so regarded when presented for college entrance.

Again, the instruction in the gas engine and the steam engine is given largely from diagrams or from models so small as to be hardly worthy of the name. In my own laboratory we have a one-half horse power gas engine which may be placed upon the demonstration table and studied by the pupils at first hand. In addition a large sized model is provided which may be connected with a spark coil and the whole internal operation of the engine—intake, compression, spark and exhaust—shown perfectly. A well known carburetor company has favored us with a large cut model of their carburetor which shows the modification necessary for use with gasoline. For the steam engine a plant is in use consisting of an engine, boiler and dynamo, the boiler being tested to a pressure of 200 pounds and working under 80 pounds. This is accompanied by a good sized model showing the internal working of the engine. Here again the horse power of the engine may be determined, the amount of gas used as fuel measured, its cost of operation calculated and by measuring the output of electrical energy, its efficiency determined. Such demonstrations are not entertainment, but work of a most practical nature, and such as cannot help but create interest in the subject. I venture to say, however, that the pupil will derive more genuine pleasure from such work than from any which is calculated merely to entertain.

The determination of the specific gravities of liquids is a subject which is usually left with few, if any, practical applications. But would it not be worth while to provide a Westphal balance for determining the specific gravities of a series of water and alcohol solutions and then by reference to the published tables obtain the percentages of alcohol? Or the hydrometer may

be used for great accuracy is not the object here, but rather to show the pupil that such determinations have real value. It would also contribute still further to this end if the pupil were allowed to distil off the alcohol from a measured volume of some patent medicine or beverage, dilute to the original volume, and by determining the specific gravity, obtain the percentage of alcohol.

For the study of electricity, every laboratory should be equipped with a 110 volt current, D. C., if possible, and wired to each table. Dynamos and motors that are more than toys should be provided and also double range commercial voltmeters and ammeters of the Weston type. With these instruments a large number of very practical problems may be made. For the study of parallel and series groupings of lamps in light circuits, I have a lamp board, made by one of my boys, and carrying the following combinations of lamps—four in series, four in parallel, eight in multiple parallel, and six in multiple series. By means of this, with a good voltmeter and ammeter, the practical aspects of electric light wiring and the consumption of electrical energy may be taught in a very effective way. In taking up the magnetic effects of the current, it is worth while to make an electromagnet of large capacity. For the heating effects an electric furnace of either the resistance or arc type is easily made. For the arc furnace a mixture of asbestos fibre, fire clay and water glass makes an excellent material. A resistance furnace may be made by winding a grooved alundum cylinder with nichrome steel wire and covering with alundum cement. Alundum is a highly infusible substance manufactured by the Norton Company of Worcester, Mass. The determination of the number of watts used by a lamp circuit, an electric flat iron or toaster and therefrom, the cost of operation is an interesting and practical problem.

While I have pointed out only a few of the ways in which the teaching of physics may be made more attractive to the pupil and grip him with a stronger appeal, I am entirely confident that the present teaching of the subject must be revolutionized along these lines. And what is true of physics is largely true of the other sciences. When the pupil feels that the problems set him are real ones, worth his time and effort, there will be no necessity for driving him, and the science subjects will cease to fall off in the number of pupils pursuing them. It may be said, however, that to equip a school for work along the lines suggested will incur an expense which will be prohibitive. It is true that the expense will be greater than under the old method of teaching with toy ap-

paratus. But if real efficiency is the object of our teaching, then expense is no consideration. The expense of such equipment is not nearly so great as might be supposed. There is much showy and useless apparatus in most of our laboratories which has cost more than the kind of apparatus suggested in this article.

Another agency which is a very strong factor in arousing interest in these subjects is a good science club. For these meetings, which should be held about once a month, speakers and demonstrators from commercial companies may very often be obtained. In my own club I have had demonstrations with thermit and oxy-acetylene welding by representatives of the Goldschmidt Thermit Company and the Davis-Bournonville Company. I have also given demonstrations with liquid air at several meetings. Other similar meetings have been held each year and several are now arranged for the present year.

The chief obstacle to the thorough presentation of science subjects along the foregoing lines in a school which must prepare for college entrance examinations is the fact that so much has been crowded into these courses and is exacted of pupils in their examinations that no one division of the subject can be carried to anything like a complete treatment of it. It is a great pity that teachers in secondary schools must be handicapped by such rigid exactions.

LATITUDE WITHOUT AN INSTRUMENT.

By T. M. Blakslee,
Ames, Iowa.

On page 110 of the February issue of this Journal, Professor Morse shows that: "The declination of an observer's zenith equals his latitude."

If one's school building has a bell tower with the front entrance steps at its base, find your latitude thus: (a) From a star catalogue find a star, the declination of which differs but slightly from your latitude. (b) From a window in the tower run out a lath or pole with a plumb line attached, determine the length of the line when it reaches to within about two feet of the steps. (c) Calculate, n the length of 1" of the circumference having the length of the plumb line as radius. (d) Calculate the star's time of passing your meridian. (e) At the instant of meridian passage, lying on your back and looking up the plumb line, deflect its lower end, m, sufficiently so that the line points to the star. (f) Find m/n. Apply this number of seconds as a correction to the star's declination. If the deflection was to the *south*, the declination is too great by m/n seconds; if to the *north*, too small by this amount. Seemingly this method should give more accurate results than those obtained by using a portable instrument, in fact, better than any save by a fixed observatory.

I have never seen this method given. However, it may be well known.

LABORATORY EXERCISES IN GENERAL CHEMISTRY—TRANSITION POINT, SUSPENDED TRANSFORMATION, LAW OF SUCCESSIVE REACTIONS.

By Wm. Lloyd Evans,
Ohio State University.

An examination of some of the recent text-books in general chemistry shows a marked tendency among the authors to approach the subject more from the side of its physical-chemical point of view than was formerly the custom. This fact, of necessity, calls for a gradual revision of the laboratory work corresponding to the movement referred to. The writer has been engaged for some time in developing some simple laboratory experiments which will serve to illustrate in a clear way these well known principles of chemistry which are gradually being incorporated into the first year's work.

An examination of many of the well-known laboratory manuals fails to reveal a suitable experiment illustrating "Transition Point" and related phenomena. Many substances lend themselves for this purpose, but there are several objections to their use by beginners in the subject. The apparatus needed for the study of many substances is not found in the ordinary outfits for elementary work. Some substances do not offer an easily observable transition point. Such compounds as cuprous mercuriiodide which is changed from the bright red variety to the black variety at 71°, and also the silver mercuriiodide which is changed from yellow to red between 40° and 50°, would seem to be ideal for the purposes intended. The objections to the use of these complex compounds are purely pedagogical ones. The beginner is not satisfied to work with substances which are so rarely met in the work as these are. Furthermore, it seems to the writer that substances of the simplest type should be used for the illustration of the various principles studied. To meet the needs here outlined, mercuric iodide has been used recently in this laboratory with considerable success. The experiments outlined below are based on the well known conduct of this very familiar compound. They are offered in the hope that they may contain some helpful suggestions to others engaged in similar work.

The following is a brief statement of the manner in which the work was carried out. A small amount of red mercuric iodide was placed in a capillary tube such as is used in making melting-point determinations, and this was fastened to a thermometer in the usual manner. The bath used was either glycerine or a mix-

ture of sulphuric acid and potassium sulphate. It was found that the students were able to obtain excellent concordance in their results for the transition point; i. e., 138°-140°. By taking a much longer time in the heating, the transition point was found in many cases to be that obtained by more mature workers; i. e., 127°-129°. To the writer, the gratifying features of the experiment were the general agreement in results, the well known exceedingly sharp transition color, and the interest which these facts created in the students in reference to the principle being studied. After noting the transition point, the temperature was raised and the melting point was observed. Here again there was a general uniformity of results. After the melting-point had been noted, the bath was allowed to cool slowly and the changes in the mercuric iodide were again observed. This same general experiment was carried through by merely holding the capillary tube itself over the free flame. As is well known, the transition of mercuric iodide into its different phases is seen to excellent advantage in this manner. Questions were asked at this point in the work in reference to the energy content of allotropic forms, physical equilibrium, analogy in behavior to other substances, vapor pressure of both forms at the transition point, etc.

In order to illustrate "Suspended Transformation," a small portion of the red mercuric iodide was carefully heated in a test-tube, until the color was homogeneously yellow, then the test-tube was cooled quickly under the water tap. At this point questions were asked bearing on the condition of yellow mercuric iodide at ordinary temperature and an effort made to correlate its behavior with supercooled water, supersaturated solutions, and monoclinic sulphur at room temperature. Furthermore appropriate questions were asked in reference to the behavior of yellow mercuric iodide when a small bit of the red variety was added and the two ground in a mortar. The same behavior was also to be noted without the addition of the red variety.

The student having thus established the fact that the yellow variety of mercuric iodide was the more unstable one, the law of "Successive Reactions" was readily illustrated. He was asked to prepare mercuric iodide by mixing equivalent amounts of dilute aqueous solutions (about O.1N) of mercuric chloride and potassium iodide. As is well known the yellow variety is first precipitated and it soon passes over to the red variety. The attention of the student was also directed at this point to the well known facts in reference to the relative solubility of the allotropic forms of any substance in a given solvent.

A NEW APPARATUS FOR EXPERIMENTS IN MOMENTS.

By J. B. Kremer,
University of Detroit.

In weighing objects with an ordinary balance, it will have been observed that every additional weight, placed on the scale pan, causes the latter to move in a horizontal direction. The ensuing motion will always bring the center of inertia of pan and weights vertically beneath the support of the scale pan. In the apparatus here described, this principle is used to show that the laws of composition and resolution of forces are applicable also to moments.

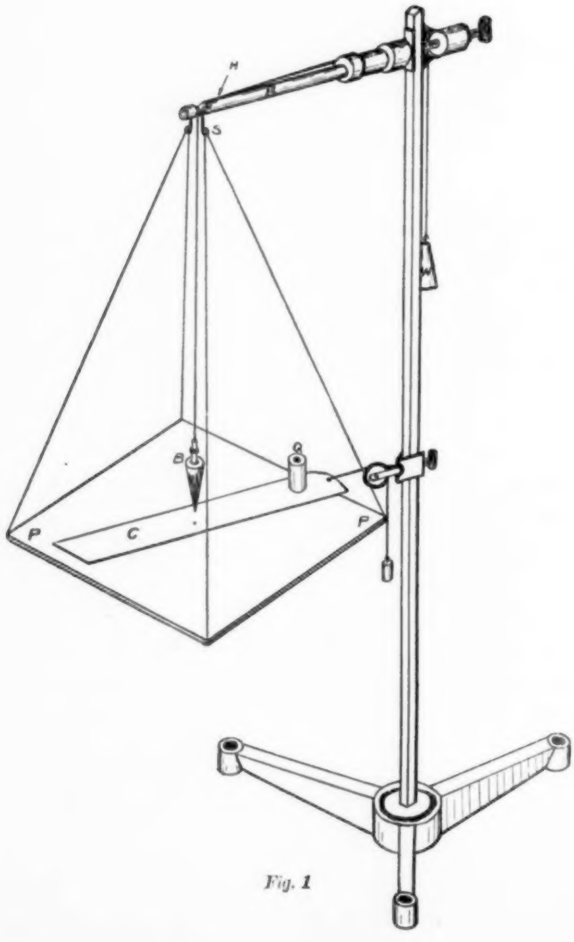

Fig. 1

The apparatus, Figure 1, consists of a light aluminum platform, PP, suspended from the rod, R, by cords attached to the stirrup, S. The diameter of the stirrup should be large compared to the rod, R, in order to give the platform perfect freedom of motion. From a point beneath the stirrup a plumb bob, B, is suspended, which will always point to the center of mass of the platform and the weights. In the figure, the apparatus is represented as used in one of the experiments. The strip of cardboard, C, and the weight, Q, are therefore supposed to be removed. In order to obtain accurate results, the point of the bob should be as close as possible to the platform. Hence, it will be necessary to raise or lower it for different positions of the platform. To make this operation easy, a counter-weight, W, is attached to the plumb bob. The cord passes through the hole, H, drilled through the rod at an angle, to leave an unbroken surface underneath the stirrup, S.

The apparatus may have any dimensions. The larger, of course, the platform, and the smaller its mass, the greater will be its sensitiveness. A piece of No. 22 aluminum sheet about a foot square will answer the purpose very well. Even a piece of cardboard will give good results.

As already stated, the apparatus serves admirably to show experimentally that moments can be composed into resultants, or resolved into components according to the laws of resolution and composition of forces. It can also be used for a number of other experiments which are applications of the same laws.

1. To Find the Weight of the Platform.

The weight of the platform can be found by measuring the distance through which it will move from its position of rest when a known mass is placed on it, at a known distance from the center. To obtain the necessary data, place a sheet of paper with a mark in the center on the platform. Adjust the paper so that the bob points directly over the mark, then put the weight on the paper. After the platform has been brought to rest, lower the bob and mark the positions of both weight and bob on the paper. Now remove the paper and draw a straight line through the three points. Since the plumb bob always points to the center of inertia of the entire system, the two masses are inversely proportional to their respective distances from the second position of the bob. The center mark of the paper is taken as the center of mass of the platform.

2. To Find the Centers of Inertia of a Number of Weights Placed Successively on the Platform, and to Find Their Resultant Moment.

If we place a number of weights on a sheet of paper lying on the platform and mark the positions of the bob after each additional weight, and then join these points by straight lines, we obtain the figure indicated by the heavy lines O P_1P_2, etc., in Figure 2. The positions of the different masses M_1, M_2, M_3, etc., can be determined by the instructor and the student required to locate, first, the position of the bob for every additional weight,

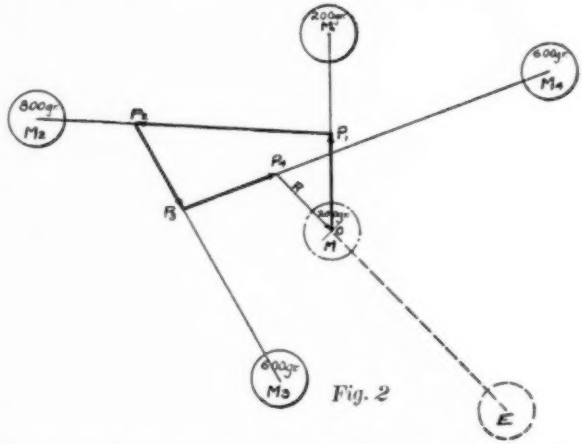

Fig. 2

secondly, the resultant moment of all the masses, and, finally, the magnitude and position of the mass required to bring the center of paper back again under the point of the bob. The solution is easily seen, if it is remembered that the first position of the bob, or P_1, is the center of inertia of the mass of the platform and the first weight, M_1. The second position of the bob, P_2, is determined by the masses $(M+M_1)$ and M_2. In like manner, all the other points can be determined. Since the position of the equilibrant must be such as to bring the bob again over O, a straight line prolonged from P_4, the last position of the bob, through the point O will be its direction. Its moment must be equal to the entire mass of platform and weights multiplied by the distance P_4O. If now the paper is adjusted on the platform and weight after weight is added, the bob will seem to travel from point to point till it points again to the center of the paper.

3. Graphic Method.

If the graphical method is used to find the resultant of two

masses about a point, as M_1 and M_2, in Figure 3, the point D, where the prolongation of the diagonal of the parallelogram of moments meets the line M_1M_2, is the center of inertia of the masses M_1 and M_2. In like manner, no matter what distance from O is chosen for the equilibrant M_3, the points E and F will always be the center of inertia of the two respective masses M_2M_3 and M_1M_3. Hence, the resultant of two moments about the same point can easily be found without constructing a parallelogram by drawing a straight line from this point to their center of inertia and multiplying this distance by sum of the two masses.

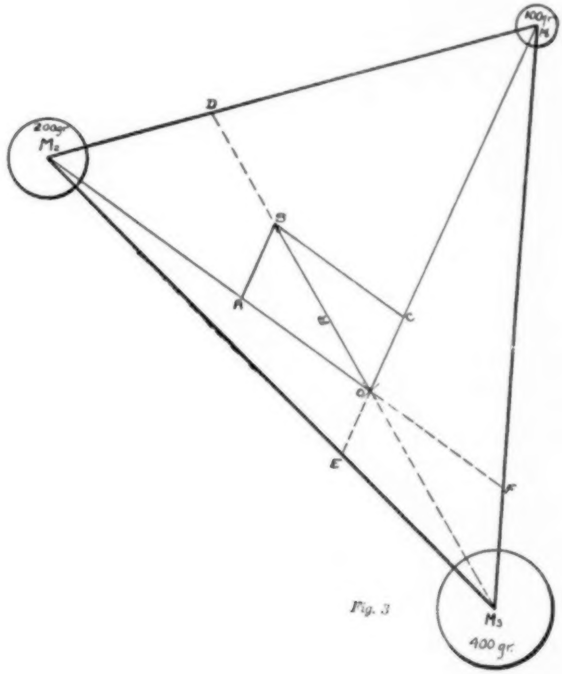

Fig. 3

The same method can be used to resolve a moment into two or more components. Let it be required to find two components of the moment of the mass, M, Figure 4, about the point O, when the positions of the masses, P and P_1, are given. Let their positions be S and S_1. Join these two points by a straight line. The center of inertia of the two masses, P and P_1, will lie on the line OQ, at a distance $OP_3 = \frac{M \cdot OQ}{P+P_1}$, and the masses will be inversely proportional to their distance from this point. Either of these

two components could be resolved into two about the point O. To verify the result prolong the line OQ, through O, making $OQ_1 = OQ$. Adjust the paper on the platform, place P and P_1 in their respective positions and M on Q_1. The bob will then point to the center O.

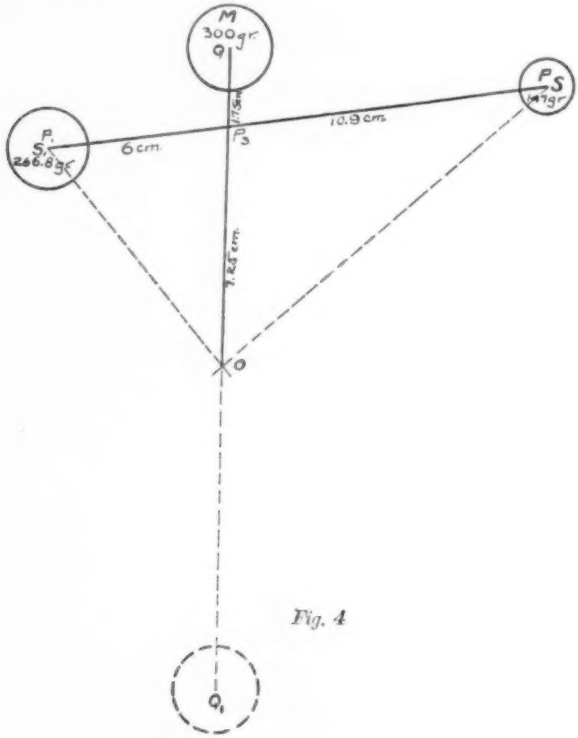

Fig. 4

4. To Find the Horizontal Force of a Mass Resting on the Platform.

This experiment is very instructive. The apparatus is set up, as indicated in Figure 1, which explains itself. The object is to find the horizontal force required to prevent the platform from moving out of its position of rest, when the mass, Q, is placed on it some distance from the center. The required force is calculated from the proportion of the two lever arms, namely, the distances from the top of rod, R, to the platform and from the center mark of the paper strip, C, to the position of the mass, Q.

5. To Show That Two or More Masses Revolve About Their Center of Inertia.

Fasten the masses to the platform by a bit of wax, mark the

position of the bob by pasting a bit of paper on the platform, then revolve the platform till the cards are well twisted and release it.

6. The Apparatus Offers Also a Quick and Easy Means of Testing the Result When the Center of Mass of a Surface Has Been Determined.

For this purpose the platform is provided with a small hole in the center just large enough to receive a pin, but accurately under the point of the bob. The necessary adjustment can easily be made by means of a little wax. After the center of mass of the specimen has been located, push a pin through this point and insert the pin into the hole in the platform. If the center of mass has been accurately determined, the bob will point to the head of the pin.

By making the platform circular in shape and pasting a bristol board circular protractor on its surface, the apparatus will serve the purpose of a force table. In this case, the weights are suspended by threads from the hole in the center over the edge of the disk.

GOLD AND PLATINUM BY THE TON.

The production of pig iron in 1912 was 33,802,685 tons of 2,000 pounds each; that of platinum was 1.3 tons. The value of the iron per ton was $12.44, as against $1,328,391 per ton for the platinum.

For the sake of convenient comparison and because in commercial practice the various ores and metals are measured by a variety of units such as the long, short and metric ton, flask, avoirdupois pound and troy ounce, the United States Geological Survey has issued a short summary of the "Production of Metals and Metallic Ores in 1911 and 1912," stated in terms of the short ton of 2,000 lbs., considerable of which however is derived from imported ores, bullion, etc. A comparison of the production of some of the better known metals may be of interest.

Production of the More Valuable Metals in the United States in 1912, in Short Tons.

	QUANTITY.	VALUE.
Platinum	1.304	$ 1,732,221
Gold	188.108	113,415,510
Silver	4,471.4	80,187,317
Aluminum	32,803	15,089,380
Quicksilver	939.9	1,057,180
Nickel	22,421	17,936,800
Tin	8.4	8,850
Copper	734,052	242,337,160

A MODEL GEYSER.

By W. H. Spurgin,
Chicago Heights, Ill.

An easily constructed working model of a geyser may be of interest to some teachers of physiography. The geyser which I shall describe plays for about 30 seconds at intervals of about two minutes and is entirely automatic.

The water reservoir consists of a copper float six or eight inches in diameter which may be obtained from any plumber. Two openings are made and rubber stoppers fitted into them. One opening leads to the pipe (1) through which the eruption takes place, which is simply a heavy rubber tube, somewhat coiled to prevent convection currents, and the other is for the return of the water after the eruption through tube (2). In the latter tube is a valve to prevent discharge of the water upward during an eruption, and is made by placing a selected wooden cork with the large end notched to prevent closure at the bottom in a piece of glass tubing a little larger than the cork and drawing out both ends in the flame. If desired, the valve may be omitted and a pinchcock, which, however, must be operated by hand, may be substituted. A large dishpan will serve as the geyser basin and the method of connecting the tubes is shown in the drawing. If desired a thermometer may be inserted into the water in the reservoir by means of an extra hole.

To operate, the bulb and tubes leading to and from it are filled with water poured into the basin. Heat is supplied by two or three Bunsen burners or a gasoline torch directly to the copper reservoir. After two or three partial eruptions all the water will become heated and so long as water is kept in the basin to make up for that lost no further attention is needed.

The geyser described had the basin about five feet above the reservoir, but the character and frequency of the eruption may be altered by changing the height.

THE LOADED TABLE AGAIN.

By Oran L. Raber,
Rushville, Ind.

In the discussion of the "Problem of the Loaded Table" in the March number of School Science and Mathematics, the author of the article has solved the problem by formulating a simple law of elastic yielding. He admits that there may be any number of laws of elastic yielding and therefore any number of values.

Why, however, is it not possible to solve the problem by the method of moments alone?

Let us start out with the four equations:

$$A + B = 80 \qquad (1)$$
$$B + C = 30 \qquad (2)$$
$$C + D = 40 \qquad (3)$$
$$D + A = 90 \qquad (4)$$

Since the point at which the load is placed, which we will call E for convenience, lies 1 ft. from side AB and 1 ft. from side AD, the distance of E from A is $\sqrt{1+1}$ or 1.414 ft. In like manner the distance from E to D is $\sqrt{1+4}$ or 2.236 ft. Then the load on A is to the load on D as 2.236 is to 1.414 or

$$A:D = 2.236:1.414$$
$$A+D:A = 2.236+1.414:2.236$$
$$90:A = 3.650:2.236$$
$$3.65A = 201.24$$
$$A = 55 \text{ lbs.}$$

Substituting in equations (1), (2), and (3) we get

$$B = 25-$$
$$C = 5+$$
$$D = 35-$$

These are practically the same answers as those obtained by the author of the article, but the method used is much more easily comprehended by the average high-school student of physics. It is doubtful whether most beginning students in physics will understand the "law of elastic yielding" and therefore it would only tend to confusion. Besides, "what's the use?"

REPLY TO "PROBLEM OF THE LOADED TABLE."

By Harry Roeser,
Stillwater, Oklahoma.

In the discussion of the "Problem of the Loaded Table" in the March issue of School Science and Mathematics the author of the article seems to have some doubt that the problem has a definite solution. I will endeavor to show in the following that the problem has one definite solution and, furthermore, this solution is based on certain well known principles of physics and mechanics.

A brief restatement of the problem may be necessary. "A table 3 ft. by 4 ft., has a leg at each of its four corners, A, B, C, and D. The table supports a load of 120 pounds at a point 1 ft. from the long side, AB, and 1 ft. from the short side, AD. What is the pressure due to this load at the foot of each leg?"

I agree with the author of the article referred to, that the solution in the text-book of which he speaks is absurd.

Letting A, B, C, D, denote the respective stresses in the legs and using in succession the line joining the points of application of each pair of forces, DC, AD, BA, CB, as an axis of moments, the following equations are readily obtained:

$$(1) \qquad A+B=80 \text{ lbs.}$$
$$(2) \qquad B+C=30 \text{ lbs.}$$
$$(3) \qquad C+D=40 \text{ lbs.}$$
$$(4) \qquad D+A=90 \text{ lbs.}$$

These equations are not independent of each other. Another and independent equation must be obtained from other considerations.

To solve the problem with the data given we must make the following assumption, that the floor is rigid, or at least so rigid that the yielding of the floor is a negligible quantity compared to the yielding of the legs. This is readily conceivable. A concrete floor resting on the ground would fulfill these conditions. A very thin floor resting on supports, say twenty feet apart, probably would not.

Under this assumption the legs, being elastic, would yield due to the load on the table. Quoting the March issue, "We might assume the yielding proportional to the square root or cube root of the pressure." It is true we might, had not a certain gentleman, named Hooke, made the remarkable discovery some two hundred years ago, that "Within the elastic limit the deforma-

tion of a body is proportional to the stress producing it." See Henry Crew's *General Physics,* page 132; Millikan and Gale's *First Course in Physics,* page 110; Kimball's *College Physics,* page 155. The above principle is generally known as Hooke's Law and the mathematical statement is as follows:

Let p be the unit stress per unit area of cross section of the body. Let s be the unit deformation or ratio of change in length to the original length. Then $\frac{p}{s} = E$, where E is a constant depending on the material and is known as the Modulus of Elasticity or Young's Modulus. See above references.

One other principle will be used to obtain that elusive fourth equation. It is, I believe, due to Clerk Maxwell, and is as follows: "For stable equilibrium the potential energy of any system is a minimum."[1] The results of the following process of reasoning make the application of this principle permissible. If we compress a spring we store up an amount of potential energy equal to the product of one-half the force and the distance the spring is compressed, or equal to the amount of work done in compressing the spring. The legs of the table are elastic and their conduct under compression, by Hooke's Law, is strictly analagous to the case of the spring. If then, we apply a force to one of the table legs, we store up in it potential energy, the amount of which is equal to the average force times the distance the leg is compressed, or equal to the "work of deformation." We may then for our case restate the above principle as follows: "For stable equilibrium the work of deformation is a minimum."

The principles involved in the solution will not be affected in the least if we consider the legs of the table as all having the same cross-sectional area.

Consider the leg carying the stress A.

Let F be the area of the cross-section of the legs in sq. in.

Let l be the length in inches.

From Hooke's Law the unit deformation is $s = \frac{p+}{E}$, and the total deformation is $ls = \frac{Al}{FE}$.

The work of deformation is, therefore, $= \frac{1}{2}A \times \frac{Al}{FE} = \frac{A^2 l}{2FE}$.

If we solve the above system of equations for B, C, and D in

[1] *Ency. Brit.,* 9th Edition, "Mechanics," Vol. XV, page 722, Art. 198.

terms of A, we may write the expression for the work of deformation in each of the legs, as follows:

$$W_b = \frac{(80-A)^2 l}{2FE}$$

$$W_c = \frac{(A-50)^2 l}{2FE}$$

$$W_d = \frac{(90-A)^2 l}{2FE}$$

The total work of deformation is then:

$$W = \frac{l}{2FE}[A^2+(80-A)^2+(A-50)^2+(90-A)^2]$$

and the one and only condition necessary that W be a minimum is, that

$$8A-440 = 0 \text{ or, that } A = 55.$$ [2]

B, C, and D are readily found to be 25 lbs., 5 lbs., and 35 lbs., respectively. These results are the same as were published in the March issue of SCHOOL SCIENCE AND MATHEMATICS. It is evident that this is also the only solution, because the expression for W is a quadratic and the curve represented by it is a parabola. It can, therefore, have only one minimum value. Furthermore the solution is entirely independent of the material or the sizes of the members of which the table is constructed, provided it is homogeneous and symmetrical throughout. Even if we did have the load "resting on an infinitely rigid table supported by an infinitely rigid floor" the load would still be distributed in the same manner.

The principle "For stable equilibrium the work of deformation is a minimum" is known as the "Principle of Least Work." It is an important one in mechanics and is met with frequently in structural work. I will illustrate it further by another problem.

Suppose we have two short posts of the same length and of different material glued together and carrying a load P. Let it be required to find how much of the load is carried by each post.

Let F_1 and F_2, E_1 and E_2 be the respective cross sections and Moduli of Elasticity. Let l be their length and R be the load carried by post F_1. Then post F_2 will carry a load (P--R). The total work of deformation will be,

$$W = \frac{R^2 l}{2F_1E_1} + \frac{(P-R)^2 l}{2F_2E_2}$$

The condition for a minimum is that,

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[2] See Wentworth's *Complete Algebra*, page 211. Rietz and Crathorne's *College Algebra*, page 67.

$$\frac{R}{E_1F_1} - \frac{P-R}{F_2E_2} = 0$$

$$\text{Whence } R = P\frac{E_1F_1}{F_2E_2+F_1E_1}$$

$$\text{and } (P-R) = P\frac{E_2F_2}{F_2E_2+F_1E_1}.$$

VARIATION OF FOCUS IN LENSES.

By J. O. Perrine,
Teachers College, Cedar Falls, Iowa.

The problem of variation in the focus of lenses presented itself in a discussion of the moving picture camera. Objects of wide variation in distance are seen in good focus. Even though objects have different distances their respective images must fall upon the film in good focus and a clear picture results. It was thought curious that this was true and the lens formula was suggested as the means of clarifying the difficulty. The formula, however, requires that for a certain value of object distance, a certain value of image distance results. According to the problem at hand, it must necessarily be true that for different values of object distance, the values of the corresponding image distance do not vary much. However one might expect that this is not true at all values of object distance. Further it may be inquired as to the importance of the focal length of the lens in the accomplishing of the result.

Consider the formula as usually applied.

$$1/y + 1/x = 1/f.$$

Where y = image distance.
x = object distance.
f = focal length.

We want to know the variation of x with the variation of y at different values of y. This is the fundamental concept of calculus and has a striking application in this case.

We want $\frac{Dy}{Dx}$ for different values of x.

$$\frac{Dy}{Dx} = -\frac{y^2}{x^2} = \text{magnification}^2.$$

In terms of the independent variable alone, namely x.

$$\frac{Dy}{Dx} = -\frac{f^2}{(x-f)^2}$$

From this expression for $\frac{Dy}{Dx}$, it is evident that accurate and easy focusing of objects depends upon the focal length. When f is small, a small change in f makes a slight change in $\frac{Dy}{Dx}$ which means that objects of varying distance would be in good focus better than a long focus lens at the same distance from lens.

The negative sign of the derivative means that an increase of object distance means a decrease of image distance. In other words, object and image move in opposite direction.

In the following data x is given in terms of f, with the idea that it may be more general in application.

x	$\frac{Dy}{Dx}$
$1f$	∞
$1.5f$	4
$2f$	1
$2.5f$	.45
$3f$	.25
$4f$	.11
$5f$	.06
$10f$	.01
$25f$	.002
$50f$	.0004
$100f$	.0001
$200f$	.00003
$300f$	.00001
$400f$	.000006
$500f$	.000004
$600f$	.000003

This data means that when an object is distant by an amount of $100f$, a difference of 1 foot between objects would cause approximately a difference in the distance of the images from another of .0001 feet. At $x = 400f$, 1 foot between x's would cause approximately .000006 feet between image distances. At other values of x, the results can obviously be obtained.

Consider as a particular case a 2 inch focal length lens. We will designate the difference of the x's and the y's by Δx and Δy *respectively*.

x	Δx	Δy
8.5 ft.	1 ft.	.0004 ft.
17 ft.	1 ft.	.0001 ft.
51 ft.	1 ft.	.00001 ft.
85 ft.	1 ft.	.000004 ft.
100 ft.	1 ft.	.000003 ft.

The facts shown by these figures may be illustrated very easily by the use of an ordinary projection lantern. The picture may be focused upon a screen. A very slight movement of the lens causes a distinct change in focus of the picture. In this case we have a reverse of the conditions as given in the data above. However, if the picture is focused carefully upon a screen, the screen may be varied within a wide range of distance and the picture is still distinct. When the screen is far away, this range is much larger than when the screen is near.

THE FRAGRANCE OF PLANTS.

Flowers either have to be curious, beautiful or fragrant to gain a place in the garden. Lacking these qualities the gardener is likely to call them weeds. The fragrance of plants does not always reside in the flowers, though we usually think of the flowers when we think of fragrant plants. The fragrance may proceed from almost any part of the plant. In the lavender, thyme, and the mint family generally, the odor is found in the leaves and stems; in the cinnamon tree the odor is in the bark of the trunks and branches; in the sassafras in the bark of the root; in the sandal-wood and camphor tree it is in the wood; in the iris, ginger and sweet flag it is the rootstock; in the vanilla, anise, and caraway, it is the fruit; in the nutmeg and tonka bean it is in the seed; and in mace it is the aril surrounding the seed. In some species, different parts of the plant have different odors; thus the orange yields one kind of perfume from its leaves, another from its flowers and still another from its fruits. In the sassafras and sweet flag the leaves have a taste and smell quite different from the taste and smell of other parts of the plant.—*American Botanist.*

TUBE-ROSE OR TUBER-OSE.

The common names of plants are derived from many sources and are often older than the scientific terms applied to them—especially if they happen to have beautiful flowers or a reputation for curing disease. In many cases the scientific names are adaptations of the older common names given intentionally by educated people, but in the common name given to that cinnamon-scented bulbous plant commonly called the tuberose we have an example of how ignorance may also contribute to the nomenclature of plants. Our plant, which in scientific parlance is *Polianthes tuberosa* has nothing in connection with roses. The popular name is a corruption of the specific name, *tuberosa*, which means "producing or resembling tubers." *Polianthes tuberosa* was apparently too lengthy for popular usage and the first half was accordingly dropped, the plant then being known as *tuberosa*, just as the florist speaks of American beauty roses as "beauties" and chrysanthemums as "mums." Apparently *tuberosa* had no meaning to the average gardener and so it gradually came to be known as tube-rose—a rose with a tube, as the name is now sometimes translated. The latest dictionaries give authority for either form of the name and so the tuber-ose is slowly becoming a tube-rose, because those who use the word are unfamiliar with the Latin. There is a large number of plants with common names derived from the scientific such as rose, aster, peony, lupine and the like, but cases in which the specific name has given rise to the common name are exceedingly rare.—*American Botanist.*

THE PHYSICS TEACHER'S HISTORICAL BACKGROUND.[1]

By F. F. Good,
Columbia University.

A physics teacher may find a great deal of material that is interesting and profitable by digging among the antiquities of science teaching. Of course the admiration for old books and old teachers grows on one, and he runs the risk of becoming a worshiper of the past—an ultra-conservative. On historical grounds, however, there is some reason to doubt whether physics as a teaching method and as a vital force in a child's education has shown much of an advance in the three centuries since the time of Sir Francis Bacon.

Three hundred years ago at the beginning of the modern scientific era, Bacon made the following pointed criticism of Aristotle's Physics—"He did not consult experience as he should have done in the framing of his decisions and axioms; but having first determined the question according to his will, he then resorted to experience, and bending her into conformity with his placets, leads her about like a captive in a procession." Teachers are constantly under temptation to imitate the authoritative attitude of Aristotle. Some very capable physics teachers of the present day admit that their teaching is formal and dogmatic and they explain that they are compelled to teach that way in order to get over the ground. "Getting over the ground" usually means satisfying prescribed requirements and having students admitted into college. It is an embarrassing fact, however, that getting over the ground may mean very unscientific and inefficient education parading under the sanction of traditional authority.

During the century following Bacon, appeared an illustrious line of educational reformers who crystallized Bacon's scientific philosophy into definite science-teaching programs. Nearly all of them in one form or another pay tribute to Bacon as the "Great Advancer of Learning." Three famous leaders of this group were John Amos Comenius, Hezekiah Woodward and William Petty. It is very instructive to anyone who thinks he is following some new ideas to open these old science books of more than two hundred years ago and see how strikingly modern their ideas are. They lived in a century of unprecedented scientific discovery. It was the age of Galileo, Pascal, Huygens, Guerick, Gilbert, Boyle, Torricelli and Kepler.

[1] Introduction to a lecture-demonstration before the New York Physics Club, February 7, 1914.

I have a copy of Ferguson's Lectures published first in 1747. David Brewster of Edinburgh in editing these lectures included the following comment, "The treasurers of science had been long concealed in the recesses of algebraical formulae, and geometrical discussion; and men of ordinary capacity were deterred from pursuing them by the repulsive form in which they were displayed. There were some works, indeed, which, from the absence of mathematical reasoning, may be regarded as exceptions to the general observation; but most of them wanted that perspicuity of stile, that method of viewing a difficult subject in different aspects, and that happy manner of illustrating the abstrusest facts in mechanical philosophy by new and ingenious experiments which the author of these experiments so eminently possessed."

Quoting from a set of physics text-books printed in 1800 entitled "Scientific Dialogues Intended for the Instruction and Entertainment of Young People in which the First Principles of Natural and Experimental Philosophy are Fully Explained," we find this general statement, "Parents are anxious that children should be conversant with mechanics and with what are called the mechanical powers. Certainly no specie of knowledge is better suited to the taste and capacity of youth and yet it seldom forms a part of early instruction." The author of this set of five elementary physics books was a minister which in those days was a good advertisement for a scientific text-book. Perhaps if some of our up-to-date texts could be written by a Reverend-scientist they would accomplish more in the hands of the average high school student. This minister deserves to have another star in his crown for the very teachable way in which he handles the difficult subject of gravitation and falling bodies. It would be a reasonably safe wager that his students had learned a great deal about gravity when they had finished such an interesting discussion. It might be dangerous to make that assumption with regard to some of our present day text-books. A hundred years ago, I imagine, students must have enjoyed reading and studying natural philosophy. There is some reason to doubt if they do today. Today it is all too common to hear high school students say they like history and literature better than physics. Physics should be one of the most popular subjects in a high school course, as well as one of the most useful. Not long ago one of my friends saw a sincere and serious student throw up her hands in the final agony of despair and exclaim—"If I only knew what I was doing!"

The first elementary physics book printed in this country and used extensively as a school text was published in completed form by a minister-teacher of Boston in 1824. The writer of this book was a woman and in appreciation of her efforts the minister said in his preface: "Mrs. Marcet did not profess to prepare a work suitable to the highest stages of education. Her aim was to accommodate an important science to the literary taste and intellectual apprehensions of persons within whose reach natural philosophy had not previously been placed—to accommodate to the use of schools, generally, a science which had hitherto been considered too abstruse and uninteresting for any, whose minds had not been disciplined and invigorated by long and regular habits of study. Instead of exhausting the intellectual energies of youth in committing to memory definitions and mathematical demonstrations, which would not be understood, she proposed to illustrate the great principles of natural philosophy by comparisons of the most familiar kind; and it is believed Mrs. Marcet has done more in this way, toward giving youth a taste for the study of philosophy than all others who have published treatises on the subject." The title of the book was Blake's Philosophy and it appeared in various editions. It was revised in 1841 by Professor Thomas Jones of the Franklin Institute, Philadelphia. For a half century following the appearance of this book came a long list of elementary texts, all of which subscribed to a similar type of teaching philosophy. They seem to have been devoted chiefly to interesting information and practical descriptions of appliances. If formal statement and involved mathematical derivation are desirable in a beginner's course, these books are appallingly delinquent, and yet, it would be very much worth while to call to witness a long line of noted scientists who were nurtured on this sort of pabulum. The books by Comstock, Arnott, Ohmstead, Jones, Parker, Draper, Lardner, Loomis, Johnston, Quackenbos and Wells belong in this class. When these texts became antiquated the physics-teaching period which followed them may be characterized by the domination of higher institutions, and a corresponding over-emphasis of formal text-book style, dignity of mathematical treatment and the quantitative laboratory course. In this respect the past thirty years constitutes a historical chapter which may be omitted from the present discussion.

The science teaching experience of three hundred years ought to be a good basis on which to frame one's physics teaching creed.

The present-day physics teacher may close his ears to the criticisms of our modern educational experts. He may disregard the clamor of the public for a type of education that is more closely related to life. He may blind his eyes to the experiences of three centuries of science education, but if he does, he ties the noose around his own neck.

Using this little survey as a suggestive historical background, my contention is that it is possible and desirable to readjust the first year physics course so that boys and girls will look forward to it with happy anticipation and will not have cause to look back upon it with disappointment and regret—to readjust physics teaching so that it will take its place beside history and literature as an educative force in the community. On this historical background rest two fundamental articles of my first year physics teaching creed.

FIRST: Physics should have a vital meaning to all students of high school age and should appeal to boys and girls alike.

SECOND: The first aim of the teacher should be to fire enthusiasm for physical inquiry.

ANTHESIS.

The term anthesis is used to indicate the period of time in which a given flower is concerned in pollination. The word is sometimes taken to mean the expanding of flowers, but many flowers, for example those without floral envelopes—calyx and corolla—have nothing to expand. The end accomplished in anthesis is, of course, the fertilization of the eggs in the young ovules and this presupposes pollination, but the causes that effect anthesis are many. In some flowers it is warmth, in other light, in still others moisture or some combination of these forces. In some plants the opening of the flowers seems conditioned on the vegetative processes of the plant, and in others, darkness rather than light produces the effect. Flowers that open in the morning may close at evening and open the next day, but those that open at night and close at dawn are less likely to open again. Many flowers, however, that close in the morning in warm weather may remain open all day when the weather is cooler. In general there is a noticeable difference between flowers that have ceased blooming and those that have closed temporarily. Usually the wilting of the corolla indicates that blooming has finished but in a few cases this is no criterion. In the spider flower, for example, the flowers open toward evening and by mid-forenoon of the next day the petals hang limp and twisted as if ready to fall from the plant. But as evening approaches they unfold once more and appear as fresh as ever until another morning comes, when they wilt again and this time do not recover. Before the day is ended they have fallen.—*American Botanist.*

RELIABILITY OF GRADES OF TEST PAPERS IN MATHEMATICS.[1]

By D. W. Werremeyer,
High and Manual Training School, Fort Wayne, Ind.

Teachers of mathematics will no doubt agree that in schools in general much emphasis is placed upon the value that is assigned by the teacher to a test paper. Assuming that the hypothesis is true it is important to know to what degree marks given by teachers are reliable.

Dearborn[2] in a study of school and university grades points out large inequalities in the standards for grading employed by different teachers. He says that one instructor gave 43% of his students the grade "excellent," and to none the grade "failure." Another one gave no one the grade "excellent" and to 14% of his students the grade "failure." While it is possible that the first instructor had a better class of students than the latter, it is hardly probable that such a difference in grades can be accounted for by saying that it represents actual differences in the classes.

Starch[3] in his study on "Grading of High School Work in English," in which he had two test papers graded by one hundred fifty-two teachers, shows great variation in the teachers' estimates of the papers.

He also made a study of the "Reliability of Grading Work in Mathematics."[4] In this study one hundred forty teachers graded a test paper in geometry. His results showed even a greater variance than in the English papers.

In the present study a definite number of test papers in geometry, algebra, and arithmetic respectively were selected from a regular test given to a regular class. These papers were graded by six teachers in the Ft. Wayne High School for the purpose of obtaining the teachers' estimate of the value of the papers. An effort was made to select the papers so that they would be representative of the best, the medium, and the poorest work of the pupils. The teachers were given their own time to grade the papers so that the work could be done under normal conditions. All papers were graded on a scale of 100.

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[1] Read before the Mathematics Section of The Indiana State Teachers Association, December, 1913, Indianapolis, Ind.

[2] W. F. Dearborn, "School and University Grades," *Bulletin of the University of Wisconsin*, No. 368.

[3] Daniel Starch, "Grading of High School Work in English," *School Review*, September, 1912.

[4] Daniel Starch, "Reliability of Grading Work in Mathematics," *Schol Review*, April, 1913.

Table I shows the grades given to five test papers in beginning geometry. The papers were numbered consecutively. The teachers are referred to by the letters A, B, C, D, E, and F, respectively. Mr. D and Mr. E were not teaching geometry at the time, but had taught geometry previous to their coming to Ft. Wayne.

A glance at the table makes it apparent that there is a great variation in the teachers' estimate of the value of the papers. The average grade of the six teachers for paper No. I is 80.5; the lowest mark is 63 and the highest 93. This is a range of 30 with a mean variation of 8.5. The average grade for paper No. II is 85.5; the lowest mark is 79 and the highest 90. This is a range of 11 with a mean variation of 3. The average grade for paper No. III is 65.8; the lowest mark is 60 and the highest 74. This is a range of 14 with a mean variation of 4.1. The average grade for paper No. IV is 82.7; the lowest mark is 55 and the highest 96. This is a range of 41 with a mean variation of 9.8. The average for paper No. V is 93.7; the lowest mark is 86 and the highest 97. This is a range of 11, with mean variation of 2.5.

TABLE I.

GRADES GIVEN BY SIX TEACHERS TO FIVE TEST PAPERS IN BEGINNING GEOMETRY.

Teacher.	I.	II.	III.	IV.	V.	Gross Deviation.
A	77	87	61	84	95	—4.2
B	84	88	65	88	95	+11.8
C	63	83	60	92	97	—13.2
D	90	86	70	96	94	+27.8
E	93	90	65	55	95	—10.2
F	76	79	74	81	86	—12.2
Average	80.5	85.5	65.8	82.7	93.7	
Range	30	11	14	41	11	
Mean Variation	8.5	3.0	4.1	9.8	2.5	

Under gross deviation (—) indicates below the average and (+) indicates above the average. Gross deviation takes into consideration all the papers of all the teachers; e. g., the sum of the averages is 408.2.

The sum of Mr. A's grades for all the papers is 404. Hence Mr. A graded 4.2% below the average. This is indicated by —4.2. Two teachers, Mr. B and Mr. D, graded above the average and the remaining four teachers graded below the average. No one teacher estimated all the papers low and no one teacher estimated all the papers high. That is, no teacher had an exceptionally low standard or an exceptionally high standard.

Table II shows the grades for five test papers in 9A algebra. The papers are numbered I, II, III, IV, V, as before and graded by the same teachers who graded the geometry papers mentioned above.

TABLE II.
GRADES IN 9A ALGEBRA.

Teacher.	I.	II.	III.	IV.	V.	Gross Deviation.
A	59	66	87	66	96	+3.3
B	55	65	73	51	90	—36.7
C	64	78	88	68	98	+25.3
D	65	77	80	59	95	+5.3
E	69	78	81	66	96	+19.3
F	54	63	74	69	94	—16.7
Average	61	71.2	80.5	63.2	94.8	
Range	15	15	15	18	8	
Mean Variation	5.0	6.5	4.8	5.4	1.9	

The gross deviation shows that Mr. B and Miss F graded below the average, and the remaining four teachers graded above the average. As in the previous set no one teacher estimated all the papers low and no one teacher estimated all the papers high.

Table III shows the grades for five test papers in 8B arithmetic. This was a class in the Training School connected with the School of Education at Indiana University. The papers were numbered I, II, II, IV, V respectively, and were graded by seven graduate students at Indiana University. Not all these students were teachers of mathematics, but all were experienced teachers with much practice in mathematics. The teachers are referred to by the letters: T, U, V, W, X, Y, and Z respectively. Mr. Z has a Doctor's degree from Teachers College, Columbia University.

TABLE III.
GRADES IN 8B ARITHMETIC.

Teacher.	I.	II.	III.	IV.	V.	Gross Deviation.
T	86	70	90	98	48	—12.2
U	90	75	95	100	50	+5.8
V	75	75	100	96	60	+1.8
W	95	78	100	100	69	+37.8
X	80	75	90	98	53	—8.2
Y	80	81	94	97	67	+14.8
Z	50	65	85	90	75	—39.2
Average	79.4	74.1	93.4	97	60.3	
Range	45	16	15	10	27	
Mean Variation	9.7	3.8	4.3	2.3	8.6	

The gross deviation shows that Mr. T, Mr. X, and Mr. Z graded below the average, and the remaining four teachers graded above the average. No one teacher graded the highest on all the papers. Of all the teachers, Mr. Z graded the lowest on papers I, II, III, and IV, and the highest on V. This may be accounted for by the fact that Mr. Z had been connected for several years exclusively with university and college work. Hence it was more difficult to adapt himself to elementary arithmetic papers.

Table IV shows the grades for five test papers in an arithmetic class in the School of Education in Indiana University. The papers were numbered I, II, III, IV, and V respectively, and graded by the same seven graduate students as in Table III.

TABLE IV.

GRADES GIVEN BY SEVEN TEACHERS TO FIVE TEST PAPERS IN AN ARITHMETIC CLASS IN THE SCHOOL OF EDUCATION AT INDIANA UNIVERSITY.

Teacher.	I.	II.	III.	IV.	V.	Gross Deviation.
T	68	70	38	38	77	—11.8
U	69	70	35	36	76	—16.8
V	87	79	58	50	86	+57.2
W	65	64	42	45	80	—6.8
X	62	50	30	20	67	—73.8
Y	72	71	43	45	86	+14.2
Z	71	71	67	48	83	+37.2
Average	70.6	67.9	44.7	40.3	79.3	
Range	25	29	37	30	19	
Mean Variation	5.2	6.2	10.1	7.7	5.1	

The gross deviation shows that three teachers graded above the average and four teachers graded below the average. Mr. X graded the lowest on all the papers, but no one teacher graded the highest on all the papers. This would indicate that Mr. X sets a high standard.

Table V shows the results of two gradings of the set of algebra papers referred to in Table II. The second grading was done about seven months later by the same teachers, except Mr. B, who had resigned. The teachers were not told that it was the same set of papers which they had graded before. Under the column "Difference" is indicated how much the grades for the respective papers by the respective teachers differed the second time from the first time; "+" indicates higher than the first time; "—" indicates lower; and "0" indicates that the same grades were given.

TABLE V.

TWO SETS OF GRADES GIVEN BY THE SAME TEACHERS TO A SET OF ALGEBRA PAPERS.

Teacher.	First Grading I.	II.	III.	IV.	V.	Second Grading. I.	II.	III.	IV.	V.	Difference. I.	II.	III.	IV.	V.
A	59	66	87	66	96	62	76	79	64	94	+3	+10	—8	—2	—2
B	55	65	73	51	90	Resigned					Resigned				
C	64	78	88	68	98	62	77	86	68	98	—2	—1	—2	0	0
D	65	77	80	59	95	65	80	80	66	95	0	+3	0	+7	0
E	69	78	81	66	96	65	89	86	69	97	—4	+11	+5	+3	+1
F	54	63	74	69	94	67	78	76	66	95	+13	+15	+2	—3	+1

Of the twenty-five grades given to the five papers by the five teachers, five were the same both times, twelve were higher, and eight were lower the second time. The greatest variance was 15%. If the same teacher varies to this extent on the same paper, it is no wonder that different teachers vary more.

Table VI shows the grades for five test papers in 9B algebra. The papers were numbered I, II, III, IV, and V, as before and graded by the teachers of the Department of Mathematics in the Ft. Wayne High School. Three of the teachers are the same as those that graded the papers in Tables I and II, and three are new.

TABLE VI.

GRADES IN 9B ALGEBRA.

Teacher.	I.	II.	III.	IV.	V.	Gross Deviation.
A	53	93	90	70	98	+2.5
B	48	90	85	82	98	+1.5
C	51	90	90	85	86	+0.5
D	58	90	85	85	87	+3.5
E	48	90	73	80	99	—11.5
F	52	92	88	79	94	+3.5
Average	51.7	90.8	85.2	80.2	93.7	
Range	10	3	17	15	13	
Mean Variation	2.7	1.1	4.2	3.8	4.8	

The gross deviation shows that Mr. E graded below the average, and the remaining five teachers graded above the average. No one teacher estimated all the papers low and no one teacher estimated all the papers high.

Table VII shows the grades for five test papers in 9B algebra. These papers were graded by the same teachers as in Table VI, after a discussion of the grades in Table VI, in a teachers meeting.

TABLE VII.
GRADES IN 9B ALGEBRA.

Teacher.	I.	II.	III.	IV.	V.	Gross Deviation.
A	96	58	58	90	92	+1.7
B	95	49	56	85	86	—21.3
C	100	62	53	90	88	+0.7
D	100	60	59	90	93	+9.7
E	100	58	66	90	94	+15.7
F	95	64	54	90	82	—7.3
Average	97.7	58.5	57.7	89.2	89.2	
Range	5	15	13	5	12	
Mean Variation	2.3	3.5	3.3	1.4	3.8	

The gross deviation shows that Mr. B and Miss F graded below the average and the remaining teachers graded above the average. No one teacher estimated all the papers low, and no one teacher estimated all the papers high. A comparison of Tables VI and VII shows that:

1st. While Mr. B graded 1.5 above the average on the first set, he graded 21.3 below the average on the second set.

2nd. While Mr. E graded 11.5 below the average on the first set, he graded 15.7 above the average on the second set.

3rd. While Miss F graded 3.5 above the average on the first set, she graded 7.3 below the average on the second set.

4th. The remaining three teachers did not vary a great deal from the average in the two sets.

5th. The total mean variation was reduced by 2.3.

6th. A discussion of the grades given to any set of papers has a tendency to result in more uniformity.

CONCLUSION.

The above tests show that a group of teachers differ greatly as to the value that is placed upon a geometry, algebra, or arithmetic test paper. It does not show that any one teacher has an exceptionally high standard, nor that any one teacher has an exceptionally low standard. Mr. Z in one set of papers graded four out of five lower than any other teacher, but on the other hand he graded one paper out of the five higher than any other teacher. Even the same teacher finds it difficult to place the same value upon the same test paper twice. (Compare Table V.) It seems that the teacher's own standard is constantly changing, or else he has no definite standard of his own to start with.

The question, "To what degree are marks reliable?" is an interesting problem that we have no data in the present study for

answering. It is also a very important question; e. g., if a county superintendent thinks that a certain paper is worth 50%, then the writer of that paper is not qualified to do high school work, or he is not qualified to teach; but if the superintendent thinks the paper is worth 75% then the writer of that paper is ready for high school, or perhaps ready to take charge of a school. It would seem to be a good plan for the teachers of a department or of a school to get together and discuss the basis for grading so as to arrive at some uniformity.

It is sometimes said that a paper in mathematics is easily graded; that it is either right or wrong. While this is true in a measure, it is not wholly true. Of course a demonstration in geometry cannot be right if it is wrong; it is not wrong if it is right. But there are other things to be taken into consideration; e. g., the figures should be drawn correctly, the special enunciation should be given, facts should be stated with reasons given leading up to the thing to be proved. If the pupil does these things, it is worth something. The question is, "How much?" Some teachers insist upon the shortest proof possible, others will give credit for a longer proof. To what degree should the former take precedence? This very fact accounts for the low grade of 55% by Mr. E for paper No. IV, Table I.

Before any definite and lasting improvements are made in the system of grading, before any degree of uniformity is reached, the systems must be worked over and clarified from the foundation up.

First of all, there must be an established and definite idea of that for which grades are given. At present marks stand for many things. They stand for latent ability, for work actually done, improvement, and so on. Marks are given for various complexes of intellectual, moral, and social qualities. Those given by many teachers are influenced by matters of discipline. These factors, of course, apply to a teacher's own pupils. They cannot enter when pupil and teacher do not know each other as is usually the case in a study of this kind.

Then as to the various qualities entering into the complex for which grades are assigned, each should have a fixed relative value assigned to it, tending toward more uniform and equitable grading.

These are the problems which must be solved before we can expect anything like an equitable system of grading. These must be at least partially settled before there is any use of going into

the question of the best means of determining this "mental ability," this "something" which we are at present grading, although not being sure of just what it is. Then and only then will we be able to tell just what part properly planned and properly conducted examinations play in assisting the teacher and the examiner in determining this ability of which we wish to know.

RED NOT A SATISFACTORY DANGER SIGNAL.

Red has been the sign of danger and a warning signal since the earliest times. Just why it was selected as a danger-warning is a question for the anthropologist and historian to determine. It is unfortunate that this color, which is becoming increasingly important with the growing danger of accidents in civilized life, is the color to which many human eyes are insensitive. Color-blindness is apparently becoming more common. In its most frequent form, it is impossible for the color-blind person to distinguish red from green, yet those two colors, which are the most confusing to the human retina, are the very ones which are in most common use as signals for danger and caution. So common is red and green color-blindness that all licensed pilots, masters of vessels, engineers, firemen, motormen and others employed in directing vessels, trains, trolly-cars and other means of transportation are required to submit to a color-test and to prove that they possess an accurate degree of red-green color perception. The simple expedient of selecting as a sign of danger a color to which practically all human eyes are susceptible has only recently been suggested. *Drugs, Oils and Paints*, in a recent issue, contains an article by Dr. Francis D. Patterson, suggesting a new signal to take the place of the familiar red warning. Patterson calls attention to the fact that the number of industrial accidents is at present enormous and is apparently increasing. As approximately one male in every twenty-five has a deficient color perception and as most of these have an impaired sensibility for red, Dr. Patterson argues that the retention of this color as a danger-signal is simply inviting further increase in accidents. His objection is based on the fact that many persons are color-blind to red and are consequently not only barred from any occupation in which a color perception is necessary, but are also deprived of the protection from accidents and danger supposed to be offered by danger-signals. He also objects to red for practical reasons; it is a fugitive color, difficult to distinguish, fading on exposure to sunlight and requiring frequent repainting. The possibility that red and green color-blindness will increase rather than diminish in the future only serves to emphasize the unfitness of these colors as signs of danger and caution. Experiments with the spectrum and with color-blind persons, as well as with various colors at different distances, leads Patterson to the conclusion that yellow and blue are the best colors for danger signals, as he says that they are the only colors which give rise to a normal color-sensation as soon as they become visible, are the most luminous colors of the spectrum, and are permanent and fast, while color-blind persons react normally to them. It has long since passed into a proverb, says *The Journal of the American Medical Association*, that it is easier to change the laws of the people than to change their customs. The fact that many persons are unable to distinguish red from other colors should alone be sufficient to cause it to be discarded as a danger signal. Whatever color is adopted should be selected after the most careful physiologic and optical investigation.

A STUDY OF STUDENT ACHIEVEMENT IN MATHEMATICS.

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Student achievement in any line of work can not be known until some definite scale of measurement is derived whereby the quality of a student's work may be accurately determined. When does a student do A+ work; C work? How do you know the work is A+ or C? Specifically, what must a student do in order to do the highest grade of work? Specifically, what is the lowest grade of work that a student may do in order to receive credit? How many grades of work shall there be between the highest and the lowest? How shall the student be placed in any of these grades? In other words, how shall we measure student attainment? When applied to mathematics of the secondary school these questions can not be scientifically answered. There is now no scientific scale for the measurement of student efficiency.

The course of study is made for the pupil. It is his possibility of success in any line of work that makes it rational for such work to be incorporated into the course of study. The prescribed work should be determined by what the pupil can do and is doing when placed in favorable surroundings. Those who prescribe the course simply place in the concrete the possibilities of student achievement. So far as high-school mathematics is concerned there is a fairly general agreement as to the character and amount of work offered. A half year work in geometry is a definite amount of work wherever that work is being done. Of course as time goes on more attention is being given to the social significance of the work, but the fundamental subject-matter remains about the same. To illustrate, at least four great recent attempts have been made to modify the work in geometry but with variations of treatment and with eliminations for the sake of adaptation the subject-matter remains unchanged.

A great amount of time has been expended upon the prescription of work and a minimum of study devoted to the determination of what the students are doing with the prescribed work. We have concerned ourselves too little with student achievement. If a scale of measurement is ever derived or discovered it will be derived or discovered in the light of what students are actually doing under a definite statement of work and with the assistance of a professionally trained body of teachers.

This brief study was undertaken for the purpose of getting some systematic and accurate information about student achievement in one high school for one semester. It is very doubtful whether conclusions may be safely drawn from this information alone. If similar data could be obtained from other cities, then it would be possible to generalize upon the character of the student's work and upon the efficiency of the department of any school.

Care has been taken to secure accurate data and an examination of the summaries appended will indicate that the work checks in every way.

Table I contains the number of students for each instructor, respectively; the number that remained in school throughout the semester; the number that dropped the subject; the number of those who dropped that were making passing (above D) and failing (D) marks; the number receiving the various marks used in this system of indicating the quality of the work of the students and the respective totals. The system of marking is as follows:

A+ represents work whose quality is 95 to 100.
A represents work whose quality is 90 to 95.
B represents work whose quality is 80 to 90.
C represents work whose quality is 70 to 80.
D represents work whose quality is below 70.

TABLE I.

Instructor.	Students remaining until they receive semester's mark.						Dropped.			Total Enrolled.
	A+	A	B	C	D	Total	Above D.	D.	Total.	
A	6	15	23	54	36	134	17	18	35	169
B	9	11	26	40	27	113	14	16	30	143
C	3	0	29	35	19	86	13	11	24	110
D	13	14	28	20	12	87	6	12	18	105
E	15	24	37	49	14	139	12	4	16	155
F	23	16	24	41	40	144	8	20	28	172
G	14	25	35	40	39	153	16	12	28	181
H	23	20	25	33	26	127	14	14	28	155
K	11	13	28	27	18	97	10	8	18	115
L	12	19	37	49	21	138	10	3	13	151
Total	129	157	292	388	252	1218	120	118	238	1456

Table No. 2 represents the same data calculated in per cent

TABLE II.

Instructor.	Students remaining until they receive semester's mark.					% on total enrollment.
	A+	A	B	C	D	D′
A	4.48	11.19	17.16	40.30	26.87	31.95
B	7.96	9.74	23.00	35.40	23.90	30.07
C	3.49	0.00	33.72	40.70	22.09	27.27
D	14.94	16.09	32.18	23.10	13.70	22.85
E	10.79	17.27	26.62	35.25	10.07	11.62
F	15.97	11.11	16.67	28.47	27.78	34.88
G	9.15	16.34	22.88	26.14	25.49	22.65
H	18.11	15.75	19.69	25.98	20.47	25.80
K	11.34	13.40	28.86	27.84	18.56	22.60
L	8.69	13.77	26.81	35.51	15.22	15.89
Total	10.59	12.89	23.96	31.86	20.69	25.41

A+ = 95 to 100.
A = 90 to 95.
B = 80 to 90.
C = 70 to 80.
D = below 70.
D′ = below 70.

Thus for instructor B; 7.96% of those who remain in school through the semester receive A+, 9.74% receive A; 23% receive B; 35.40% receive C; 23.95% receive D. The last column in this table is the per cent of failures based upon the total enrollment. It is obtained as follows: To the number of those who made D for the entire semester was added the number who were making D when they withdrew from school or from the class. This number was divided by the total number enrolled during the semester. Thus for instructor B; 27 (the number receiving D for the semester)+16 (the number who were making D when they withdrew), is divided by 143 (the total enrollment).

In the judgment of the writer this is the equitable and just method of determining the per cent of failures based upon the total enrollment in class. It is unjust to consider all those who withdrew as failures. A consideration of Table I will show that more than one-half (50.42%) of those who withdrew were making passing grades when they withdrew from the classes. It is fair to assume that the number of those who were making passing grades when they withdrew, and would have failed had they continued in school, would have been practically equaled by the number of those who were failing when they withdrew but would have passed had they remained in school—in view of the fact that each list contained about equal numbers.

The totals in per cent are matters of considerable interest. Of those who remained in school throughout the semester 10.59% received A+; 12.89% received A; 23.96% received B; 31.86% received C; and 20.69% received D (fail). Of the total enrollment 25.41% fail. The central tendency is therefor C (approximately 75). More than one-half of the students get below 80, and nearly one-third get between 70 and 80.*

TABLE III.

Subject.	Remaining throughout the semester.			Total Enrollment.		
	Number.	D. or [Failure]	Per cent of D.	Number.	D. or [Failure]	Per cent of D.
Math. I	229	57	24.89	299	89	29.77
Math. II	343	81	23.61	399	114	34.21
Math. III	234	66	28.55	289	92	31.83
Math. IV	174	28	16.09	213	53	24.76
Math. V	125	13	10.40	133	13	9.77
Math. VI	42	1	2.37	45	1	2.22
Math. VII	37	6	16.22	40	6	15.00
Math. VIII	14	0	0.00	15	0	0.00
Math. IX	20	0	0.00	23	2	8.06
Total	1218	252	20.69	1456	370	25.41

Math. I. Algebra, 1st Semester.
Math. II. Algebra, 2nd Semester.
Math. III. Plane Geom., 3rd Semester.
Math. IV. Plane Geom., 4th Semester.
Math. V. Algebra, 5th Semester.
Math VI. Solid Geom., 6th Semester.
Math. VII. Arith., 7th or 8th Semester.
Math. VIII. Alg. and Geom. Rev., 8th Semester.
Math. IX. Trigonometry, 8th Semester.

One of the most important problems concerning any department—school or system as well—is to determine the place or subject in the course where there is the greatest number of failures. For obvious reasons the time of the student should be conserved and the number of repeaters minimized. In order to determine this fact the information of Table III has been collected. The per cent of failures has been determined upon two bases—the number remaining in class throughout the semester, and the whole number enrolled. Upon the former basis it will be observed that the greatest mortality is in Math. III (beginning plane geometry) whereas in Math. VIII (review algebra and geometry) and trigonometry every student passed. The latter

subjects are elective and the classes are made up of the very best students in the school. Upon the second basis the greatest mortality is in Math. II (34.21%) (second semester in algebra) with Math. III (31.83%) a close second.

To the casual observer the per cent of failures seems to be unusually large. The explanation of this must be attempted with great care and caution. Is this per cent too large? In order to answer this question it would be necessary to have data from other schools similar to the one under consideration, and a scientific scale of measurement. A comparison of results would indicate the comparative standing of the schools in this particular. A statement that these per cents are either too high or too low must be validated by facts to be of value.

Assuming that the per cent of failures is too large, then the cause must be found in one or more of the following sources: the previous training of the students, the character of high-school instruction, and the course of study. Whereas, if we assume that the per cent of failures is too low then the cause must be found in either or both, the character of the high-school instruction, and the course of study. No assumption is justified by the facts obtained for this study. As previously suggested, the problem will be clarified by a comparative study of the work of many of the high schools in the country. However, as a working ideal for the department it may be safe to assume that the per cent of failures is too large.

It would be unwise not to call attention to the reasonable conclusion, that not all of the 238 students who withdrew from class or from school did so because of failure in mathematics. What are the facts? One hundred and twenty (or 50.42%) were making passing grades when they withdrew. One hundred and eighteen were failing in mathematics. It is not reasonable to assume that sickness, work, moving from the city, etc., would affect only those who are making passing grades, but it is fair to assume that such causes would be as likely to affect a student who is not passing as a student who is passing. Moreover, 57 students who were failing were permitted to drop mathematics and remain in school, hence we have sixty-eight pupils whose withdrawal from school might be chargeable to the failure in mathematics, yet when we consider the causes suggested, it is safe to conclude that during the semester only a very small per cent dropped out of school because of failure in and dislike for mathematics.

Such a comparative study as previously suggested would result in much useful information upon the vexed question of the achievement of students in the light of the prescribed course of study. From such a study also there will eventually be derived or discovered a standard whereby the quality of a student's work may be more accurately determined. A study of the systems of marking used by teachers will disclose, it is believed, a wide variation and consequently the real or actual value of a student's work is to some extent a matter of guess. Let us hope that the day is at hand when this matter shall be placed upon a scientific basis and that student efficiency may be measured.

WHAT THE GROWING CHILD NEEDS.

The appetite of a growing boy is a constant source of astonishment to his mother, and the ease with which he consumes more food than the adult members of the family convinces her that his tastes are abnormal. She forgets that in the second period of rapid growth that comes early in the "teens" Nature is making every effort to build a perfect individual and needs all the help she can get. She cannot build without a wealth of material, and so every boy who is physically more active than his father and mother, who is using his brain for study and growing rapidly besides, needs an abundant supply of food. What should this food be? Should his diet be limited or his taste questioned? Generally speaking, no. He needs all kinds of food, and he generally craves what he needs. He needs protein to build a man's frame and he needs a larger proportion of it than the average adult requires. He also needs fat and starches to furnish the heat and energy burned out in his ever-active body and to keep his tissues plump and rounded. While he needs much protein, do not expect him to get it all from meat. Indeed, it is better that no small part of this nitrogenous food come from milk and eggs, cheese, beans and peas. If he has plenty of these rich and relatively cheap foods he will not crave meat so inordinately as some growing boys do. The boy needs a large quantity of carbohydrates. That is why his demand for bread and butter is limited only by the supply at hand, and why he uses almost as much butter as bread. Let him have all he wants. By the pound, butter is expensive, but it is pure, wholesome food, and he can use it readily. It will not make him ill; quite the contrary. And do not be afraid of sugar and sweet foods. Sugar is a true, concentrated food. Give him candy for desert. He craves it and his craving is natural, not abnormal. The boy's instincts will lead him to choose the all-around diet he needs. To limit his choice to a few articles compels him unconsciously to overuse the one he likes the best. To regulate his diet to the tastes or foods of his father or mother is cruelty and will probably result in an undernourished child. If grown people wish to experiment on new foods they have the right to do so, but they do not have the right to inflict their ideas of what is good for them on their growing children. Good food in variety and plenty of it is what the child needs, and if it is provided his taste will not be abnormal nor will his astonishing appetite result in more than healthy rapid growth.

PROBLEM DEPARTMENT.

By E. L. Brown,
Principal North Side High School, Denver, Colo.

Readers of this magazine are invited to send solutions of the problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott Street, Denver, Colo.

Algebra.

376. *Proposed by A. C. Smith, Denver, Colorado.*

If m and n are roots of the equation $ax^2+bx+c=0$, find the value of $m^4+m^2n^2+n^4$.

Solution by William W. Johnson, Cleveland, Ohio, and N. P. Pandya, Baroda, India.

From the theory of Quadratic Equations, we have

$$m+n=-\frac{b}{a}, \text{ and } mn=\frac{c}{a};$$

hence

$$m^2+mn+n^2=\frac{b^2}{a^2}-\frac{c}{a},$$

and

$$m^2-mn+n^2=\frac{b^2}{a^2}-\frac{3c}{a}.$$

$$m^4+m^2n^2+n^4 \equiv (m^2+mn+n^2)(m^2-mn+n^2).$$

Whence

$$m^4+m^2n^2+n^4=\left(\frac{b^2}{a^2}-\frac{c}{a}\right)\left(\frac{b^2}{a^2}-\frac{3c}{a}\right)$$

$$=\frac{(b^2-ac)(b^2-3ac)}{a^4}$$

377. *Proposed by H. E. Trefethen, Waterville, Me.*

If in the equations, $x^2+xy+y^2=a$, $x^2+xz+z^2=b$, $y^2+yz+z^2=c$, a, b, c are in arithmetical progression, then also are $x, y\ z$; and conversely, if x, y, z are in arithmetical progression, so also are a, b, c.

Solution by Mabel G. Burdick, Stapleton, N. Y., and I. L. Winckler, Cleveland, Ohio.

$$x^2+xy+y^2=a \quad (1) \qquad \text{Also } 2b=a+c.$$
$$x^2+xz+z^2=b \quad (2)$$
$$y^2+yz+z^2=c \quad (3)$$

Since $2b=a+c$ it follows that $x^2+xy+y^2+y^2+yz+z^2=2x^2+2xz+2z^2$. Combining terms and factoring this gives $[2y-(x+z)][y+(x+z)]=0$. From which it follows that $2y-(x+z)=0$, or $2y=x+z$, which was to be shown.

In the second case we have $2y=x+z$ and wish to show that $2b=a+c$. Adding (1) and (3) and subtracting from this sum twice (2) we have $(x^2+xy+y^2+y^2+yz+z^2)-(2x^2+2xz+2z^2)=(a+c)-2b$.

Combining terms and factoring on the first side we have $[2y-(x+z)][y+(x+z)]=(a+c)-2b$.

Since $2y=x+z$ the first side of the equation reduces to zero and hence $(a+c)-2b=0$, or $a+c=2b$.

Geometry.

378. *Proposed by J. H. Smith, San Francisco, California.*

By elementary methods, prove that the altitude of the maximum cylin-

der that can be inscribed in a right circular cone is equal to one-third the altitude of the cone.

I. *F. Eugene Seymour, Trenton, N. J., and T. M. Blakslee, Ames, Iowa.*

Call the altitude of the cone h and the radius of the base r. Also call the altitude of the cylinder y and the radius of its base x. Then we are to determine what value of y will make the expression $\pi x^2 y$ a maximum.

From similar triangles we have at once: $\dfrac{h}{h-y} = \dfrac{r}{x}$, from which $x = \dfrac{r(h-y)}{h}$. Substituting this in the above expression we have $\dfrac{\pi[r(h-y)]^2 y}{h^2}$ as the expression whose maximum is desired.

Since π, r and h are constants this will be a maximum when $y(h-y)^2$ is a maximum. And this will be a maximum when $2y(h-y)^2$ is a maximum. In this last expression we have the product of three factors, namely, $2y$, $h-y$ and $h-y$ which have a fixed sum namely $2h$. Their product will therefore be a maximum when they are all equal. That is, when $2y = h-y$ or when $y = \frac{1}{3}h$.

II. *Solution by Norman Anning, Meaford, Ontario.*

As the altitude of a cylinder inscribed in a right circular cone increases its diameter decreases. The maximum is reached when for a small change of altitude the volume lost in one place is gained in another.

Compare the cylinders of altitude H and H$+a$ where a/h is small.

Then the circular disk of thickness a and radius $r/h(h-\text{H})$ has the same volume (neglecting small quantities of higher order) as the circular tube of length H, of thickness $r/h \times a$ and of outside radius $r/h(h-\text{H})$.

$$a\pi[r/h(h-\text{H})]^2 = ra/h \times \text{H} \times 2\pi[r/h(h-\text{H})]$$
$$h-\text{H} = 2\text{H}$$
$$h = 3\text{H}$$

III. *Solution by Hugo Brandt, Boston, Mass.*

This is proved if it can be shown that any change of the dimensions of that inscribed cylinder diminishes its contents.

Let r be radius and h altitude of cone; v be volume of the inscribed cylinder with $h/3$ as its altitude; x be any change of radius of cylinder and A the corresponding change of volume of cylinder.

Then we have

$$v = (\tfrac{2}{3}r)^2 \pi h/3,$$

and

$$v + \text{A} = \pi(\tfrac{2}{3}r + x)^2(h/3 - hx/r).$$

By subtraction,

$$\text{A} = \pi h[\tfrac{4}{9}rx + \tfrac{1}{3}x^2 - \tfrac{4}{9}rx - \tfrac{4}{3}x^2 - x^3/r].$$
$$= -\frac{\pi h x^2}{r}(r+x).$$

Obviously A is negative for all possible values of x if only $r+x$ is positive. Clearly $r+x$ is positive when x is positive. if x is negative, it can, according to conditions, amount to only $(-\tfrac{2}{3}r)$.

Therefore $r+x$ is always positive and A is, therefore, negative.

Hence the proposed cylinder is the maximum one that can be inscribed in the cone.

379. *Proposed by Norman Anning, Meaford, Ontario.*

To construct, with straight-edge only, the join of a given point to the inaccessible point of intersection of two given straight lines.

I. *Solution by A. M. Harding, Fayetteville, Ark., and H. C. McMillin, Washington, Kans.*

Draw any three concurrent lines OX, OY, OZ. Let the given lines cut OX and OZ in A, B, and A′, B′, respectively. Draw PA and P′A′ cutting

OY in C and C′ respectively. Produce BC and B′C′ to meet at R, then the line PR passes through Q.

Proof. The triangles ABC and A′B′C′ are in perspective from O, hence their corresponding sides meet in collinear points P, R, Q.

II. *Solution by Levi S. Shively, Mount Morris, Ill.*

Let MN and M′N′ be the given lines and P the given point. Through P draw two lines one of which meets MN in B and M′N′ in A, the other meeting these same lines in A′ and B′ respectively. Draw AA′ and BB′ and let these lines meet in R. Through R draw a third line which intersects MN and M′N′ in C and C′ respectively. Draw AC and A′C′ meeting in Q. Then PQ is the required line.

Proof: Suppose T to be the inaccessible point of intersection of the two given lines. Applying the theorem of Menelaus to triangle BCR we have

$$\frac{BT}{TC}\cdot\frac{CC'}{C'R}\cdot\frac{RB'}{B'B} = -1. \qquad (1)$$

Similarly with triangle RCA:

$$\frac{RC'}{C'C}\cdot\frac{CQ}{QA}\cdot\frac{AA'}{A'R} = -1. \qquad (2)$$

And with triangle BRA:

$$\frac{BB'}{B'R}\cdot\frac{RA'}{A'A}\cdot\frac{AP}{PB} = -1. \qquad (3)$$

Multiplying equations (1), (2) and (3) gives

$$\frac{BT}{TC}\cdot\frac{CQ}{QA}\cdot\frac{AP}{PB} = -1.$$

Which by the converse of Menelaus' theorem proves that P, Q, and T are collinear.

380. *Proposed by Editor.*

Let AB and CD be two parallel chords of the circle O. Show how to inscribe a circle in the segment ABDC tangent to the two chords and the given circle.

Solution by Nelson L. Roray, Metuchen, N. J., and I. N. Warner, Platteville, Wis.

Evidently the center of the required circle is on the chord which is parallel to the given chords and mid-way between them. Hence its radius is ½ the distance between the two given parallel chords. Also from *Pl.* Geometry if the two circles are to touch internally the distance between their centers must equal the difference between their radii. Hence with this difference as a radius and the center of the given circle as a center strike off arcs on the middle parallel. Hence the center and radius are determined. The proof is inferred from the construction.

Credit for Solutions.

371, 372, 374, 375. N. P. Pandya, Baroda, India. (4)

376. Norman Anning, A. Bagard, Lloyd C. Bagby, Hugo Brandt, Mabel G. Burdick, D. J. da Silva, Louise B. Foster, W. M. Gaylor, A. M. Harding, G. H. Jamison, C. H. Jhaveri, C. E. Jenkins, William W. Johnson, L. E. A. Ling, R. T. McGregor, H. C. McMillen, L. R. Odell, N. P. Pandya, D. H. Richert, Nelson L. Roray, M. G. Schucker, Elmer Schuyler, F. E. Seymour, P. K. Shah, C. C. Steck, I. L. Winckler. (26)

377. Norman Anning, A. Bagard, T. M. Blakslee, Mabel G. Burdick, D. J. da Silva, Louise B. Foster, W. M. Gaylor, A. M. Harding, C. H. Jamison, C. H. Jhaveri, L. E. A. Ling, L. R. Odell, N. P. Pandya, Nelson L. Roray, M. G. Schucker, Elmer Schuyler, F. Eugene Seymour, P. K. Shah, I. L. Winckler. (19)

378. Norman Anning, T. M. Blakslee (4 solutions), Hugo Brandt, A. M. Harding, Nelson L. Roray, M. G. Schucker, Elmer Schuyler, F. Eugene Seymour, L. E. A. Ling (2 solutions), D. J. da Silva, Hugo Brandt. (15)

379. Norman Anning, T. M. Blakslee, D. J. da Silva, A. M. Harding, H. C. McMillen, M. G. Schucker, Elmer Schuyler, Levi Shively, I. L. Winckler. (9)

380. Norman Anning, A. Bagard, T. M. Blakslee, Kearn B. Brown, Mabel G. Burdick, D. J. da Silva, A. M. Harding, Alexander C. Johnson, W. F. Lady, L. E. A. Ling, H. C. McMillin, N. P. Pandya, Nelson L. Roray, M. G. Schucker, Elmer Schuyler, I. N. Warner, I. L. Winckler, Lester E. Young. (18)

Total number of solutions, 91.

PROBLEMS FOR SOLUTION.

Algebra.

391. *Proposed by Letitia R. Odell, Denver, Colorado.*

Show that $1^3+2^3+3^3+ \quad . \quad . \quad . \quad +n^3 = (1+2+3+ \quad . \quad . \quad . \quad +n)^2$.

392. *Proposed by Editor.*

Prove that the problem of "the duplication of the cube" is the same as that of "finding two mean proportionals."

Geometry.

393. *Proposed by W. M. Gaylor, Sag Harbor, N. Y.*

If upon the sides of any right triangle equilateral triangles be constructed, the lines joining the centers of these triangles form an equilateral triangle.

394. *Proposed by Daniel Kreth, Wellman, Iowa.*

Given, the perpendicular, median, angle-bisector from the same vertex of a plane triangle, to construct the triangle and find a formula for its area.

395. *Proposed by F. Eugene Seymour, Trenton, N. J.*

In Greenleaf's National Arithmetic are found the following directions for finding the area of the segment of a circle:

Find the length of the chord. (Its distance from the center is given). Take $\frac{2}{3}$ of its product by the height of the segment and add it to the cube of the height of the segment divided by two times the length of the chord. Discuss the accuracy of this method.

ARTIFICIAL DAYLIGHT.

The high efficiency of the new nitrogen-filled, tungsten filament, incandescent lamps is the characteristic that first attracts attention to the advance they represent. With a current of 20-30 amperes, they have a consumption of 0.4 to 0.5 watts per candle power, and a life of 1,000 hours or more. Another advantage is the color of the light. The temperature of the filament being from 400 to 600 degrees higher than that of ordinary lamps, the light is of a much whiter color, and according to Langmuir and Orange, it comes closer to daylight than any other form of artificial illuminant except the d-c arc and the special Moore tube containing carbon dioxide. Work is at present under way to develop special color screens which when used with this light will give a true daylight color (corresponding to the radiation from a black body at 5,000 degrees centigrade).

SCIENCE QUESTIONS.

By Franklin T. Jones,
University School, Cleveland, Ohio.

Readers of School Science and Mathematics *are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.*

Questions and Problems for Solution.

148. *Proposed by Harvey Roeser, Oklahoma Agr. & Mech. College, Stillwater, Okla.*

Some trouble is experienced in railroading on account of the rails "creeping." If a heavy train is running west do the rails have a tendency to "creep" towards the west or east? Why?

149. *Proposed by W. A. Tippie, Troy, Ohio.*

A pendulum which beats seconds accurately at a place where the value of g is 980.9424 is transferred to a place where g is 980.3161. How will its time compare with the true time at the end of a day?

150. *Proposed by a student in West High School, Minneapolis, Minn., through Miss Jessie Caplin, Teacher.*

Why is the following statement correct:

Weight of 1 liter of a gas $= 1/100$ molecular weight$+$specific gravity referred to air as a standard?

A Physics List—*Proposed by Karl A. Zeller, South High School, Pittsburgh, Pa.*

The following problems and questions were given to the Junior Physics Class, for their mid-year examination. The *data* for the problems was collected by different boys of the class; but these problems had never been *presented* to them. A number of similar problems had been given during the semester. The principle of the hoist crane and jack screw had been worked out, from data taken in the laboratory.

We use very few formulae in the problem work, preferring to reason out the results from the definition of the units and from the direct statement of the principle involved.

For example, to find the pressure on a lock gate, the average or resultant pressure is found per square foot, as shown in the force diagram, and multiplied by the area of the surface, in contact with the water, in sq. ft. We find that it gives a better understanding of the problem than the use of the formula, Pressure $= A \times h/2 \times 62.5$.

Parts (b) and (c) of number six were given, to bring to notice the work done by the heat absorbed, with its relation to "quantity of heat," and temperature change. Also incidentally, to get away from the ice and water bondage.

Without further comment I wish to submit the list for suggestive criticism, through School Science and Mathematics.

Please answer serially numbered questions from this list.

Junior Physics—January 30, 1914.

Mechanics and Heat.—Time two hours.

In all problems, mark each numerical value, showing what that value stands for—as cm., per., sec., gain in vel.—dynes of force—etc.

1. This problem is given to show the relation between the gain in vel. (in this case less in vel.) and the unbalanced force acting; the time it acts and the mass retarded.

151. Problem—A gasoline launch of 1,000 kilograms mass is running

in still water, 9 kilom per hr. The engine is stopped and the resistance of the water brings the boat to rest in 50 sec.—Find

(a). The distance the boat goes before coming to rest.

(b). The average resistance in dynes.

(c). The amount of work done in ergs, by the water resistance in stopping the boat.

(d). The K. E. the boat possessed in ergs, when the engine was shut off.

152. 2. Hoisting Crane—.The load lifted is 20,000 pounds. The tie beam is set at an angle of 45 degrees with the upright. The rope over the pulley in the end of the tie rod, is at an angle of 90 degrees with the up-right. Find the tension in the rope and the compression in the tie rod. Use scale; one cm. equal 200 pds. (15%).

153 3. The new steel barges made by Jones and Laughlin, are 209 feet long, 26 feet wide, 8 feet 8 inches deep, and weigh 130 tons. The Monongahela river water has a density of 1.002. How many tons of coal can one carry, when loaded so that it sinks 6 feet? (15%).

154. 4. It was found in the laboratory that the efficiency of a jack screw was 25%. The buildings in the hump district were raised with jack screws, while new cellar walls were being constructed. If each jack screw was equipped with a 14 inch lever, had 4 threads to the inch and exerted a lift of 2,400 pounds, what force did a man have to use at the end of the lever? Use 3 and 1/7 for the value of 3.1416. (15%).

155. 5. Each pump at the South Side Station lifts 7,000,000 gallons of water 360 feet high in 24 hours. A gallon of water weighs 8.3 pds. If the efficiency of the pump is 90%, what is its horse power? (10%).

156. 6. (a). What properties must a liquid used in making a thermometer possess?

(b). When heat is applied to a beaker partly filled with solid paraffin, the temperature remains constant, as long as any paraffin remains in the solid state. What work is done by the heat energy absorbed by the paraffin?

(c). When all the paraffin is melted the temperature rises. Now what work is done by the heat energy absorbed?

(d). How do (b) and (c) show the difference between temperature and "quantity of heat?"

(e). A 1,000 gram iron ball, sp. ht. 0.11, is placed in the flue of a furnace. After it has absorbed enough heat to become the same temperature as the flue gases, it is dropped into 4,000 grams of water at 15 degrees C. The resulting temperature is 30 degrees C. What was the temperature of the flue gases? (20%).

157. 7. Draw four figures showing the four stages, in a complete operation within the cylinder of a gas engine. Assume four single strokes necessary in such an operation. Show the position of the piston in each stage, and whether the valves that admit and release the gas, are open or closed. (10%).

SOLUTIONS AND ANSWERS.

131. *Proposed by A. Bjorkland, Appleton, Wis.*

Concerning the re-winding of a clock magnet to use current at 32 instead of 8 volts. The original winding consists of 120 feet (700 turns) of D. C. C. copper wire.

Solution by the proposer:

The ampere turns on the magnet and the energy supplied by the current must remain the same. Since the current must be decreased to one-fourth the number of turns must be increased four fold. The current is decreased to one-fourth by increasing the resistance 16 fold. This is accomplished by having four times the number of turns (which means four times as long a wire if the dimension of the coil remains the same,

as it should) and reducing the cross section of the wire to one-fourth. The cross-sectional area of No. 31 wire is 79.7 cir. mils. as compared with 320.4 for No. 25. This is sufficiently near. In order that the dimension of the coil may remain the same the total diameter of the new wire should be one-half of that of the old. Single cotton covered No. 31 wire has a diameter of 12.5 mils. as compared with 26 for No. 25. Hence the new winding should be of 480 feet (2,800 turns) of S. C. C. No. 31 copper wire. If a better insulation is thought necessary double silk covered wire may be used.

132. *From Hale's Calculations of General Chemistry, p. 103, No. 162.*

12 grams of an alloy of aluminum and zinc (containing 33⅓ per cent of zinc) were placed in a vessel containing 180 grams of hydrochloric acid (35 per cent HCl). What volume of hydrogen, at standard conditions was liberated? (Ans. given as 11,290 cc.)

Solution by R. T. McGregor, Coleville, Cal.

Since 33⅓% of the alloy is zinc, 4 g. is zinc, and 8 g. aluminum. The reaction of the HCl on the zinc is expressed by the equation $Zn+2HCl = Zn\,Cl+2H$ and the reaction of HCl on the aluminum is expressed by the equation $Al+3HCl = Al\,Cl_3+3H$. Employing the atomic weights of Zn Cl_2 and Al given in Williams' Elements of Chemistry, which are 64.91, 35.18, and 26.91 (taking H as 1), respectively, we obtain from the first equation $\frac{2\times4\times1000}{64.91\times.0896}$ cc. of H from the action of the acid on the Zn and from the second equation $\frac{3\times8\times1000}{26.91\times.0896}$ cc. of H from the action of the acid on the Al. The first comes out 1375.5 cc. and the second 9953.8. The sum of the two is 11329+ cc. of H liberated, taking a liter of H to weigh .0896 g.

133-134. *Concerning a high school and a college examination paper.* (See SCHOOL SCIENCE AND MATHEMATICS, February, 1914, pages 162-3.)

Remarks by the Editor.

These two papers came into the Editor's hands at about the same time and seemed to illustrate a fact *in general* true concerning secondary and college work.

In general, secondary teaching is more definite and more thorough than college teaching. The college instructor broadcasts the field he covers and trusts to individual initiative on the part of the student to learn enough to show results when harvest time (examination) comes. The secondary teacher is dealing with younger and less mature students so he not only instructs, but teaches and causes (should cause) the student to assimilate the work he covers.

Apparently, the high school examination paper is likely to be more difficult than that given the college student after the same period of instruction.

135. *Proposed by W. L. Bauchman, East St. Louis, Ill.*

Three complete turns of a rope are taken around a rough post and one end of the rope is held with a force of 100 lbs. weight. What force would be required at the other end in order to make it slip, if the coefficient of friction is 0.3?

Solution by W. A. Tippie, Troy, Ohio.

If a rope is passed round and round a rough post it may be shown that the tension is increased in the ratio $e^{2\mu\pi}$ for each turn, or

$T = T_0 \cdot n\,\{e^{2\mu\pi}$ where T_0 is the initial tension, n, the number of turns and μ, the coefficient of friction.

Substituting in above formula

$$T = 100 \cdot 3 \cdot e^{.6\pi}$$

$$\begin{aligned}
\text{Log } e &= 0.43425 \\
\\
\text{Log } e^{.6\pi} &= 0.81854 \\
\text{Log } 3 &= 0.47712 \\
\text{Log } 100 &= 2.00000 \\
\text{Log } T &= 3.29566
\end{aligned}$$

$$T = 1975.4 \text{ lbs.}$$

136. *Proposed by F. E. Daniell, Terrell, Texas.*

Give a discussion of the following equation for finding the time in which a ball will roll down an inclined plane

$$t^2 = \frac{L^2}{\frac{1}{2}gH}$$

Where L is the length, H the height of the plane, t the time and g is gravity.

Solution by Niel Beardsley, Todd Seminary for Boys, Woodstock, Ill.

The equation given does not give the time of a ball rolling down a plane, but gives the time for an object sliding down a smooth plane under the influence of gravity and without friction. To obtain this equation, let MN be a plane of length L and height H. Let the line g be drawn parallel to and proportional to gravity, f parallel to the plane and n normal to the plane. Then from the triangle of forces the object would be in equilibrium under these three forces. Therefore f is the force causing the object to slide down the plane. From the triangle of forces

$\frac{f}{W} = \frac{H}{L} = \frac{a}{g}$ the accelerations being proportional to the forces.

Hence, $\quad a = \frac{gH}{L}$.

$t^2 = \frac{L}{\frac{1}{2}a}$ from the formulae for uniformily accelerated motions.

Substituting value of a

$$t^2 = \frac{L^2}{\frac{1}{2}gH}.$$

To obtain the formula desired of a ball rolling. Let a ball of radius R and weight W lb. roll without sliding down an incline from rest. The external forces are W pounds at C vertically downwards, the reaction N normal to the plane and the friction f up the plane. Unless there were friction the ball would slide.

The point of contact O is the instantaneous center of rotation. Then a being the linear acceleration of the center of gravity C, the resultant force along the plane is $\frac{Wa}{g}$. Revolving along the plane, normal to the plane and taking moments about C the three equations of motion are

$$\frac{Wa}{g} = W \sin\theta - f$$

$$N = W \cos\theta$$

$$fr = \frac{I\alpha}{g}$$

I is the moment of inertia.
α is the angular acceleration.

for a ball $\qquad I = \frac{2WR^2}{5}$

since the ball rolls without sliding

$$a = r\alpha$$

Hence we find that

$$a = \frac{5g \sin \theta}{7}$$

$$\sin \theta = \frac{H}{L}$$

$$a = \frac{5gH}{7L}$$

$$\text{from } L = \tfrac{1}{2}at^2 \text{ or } t^2 = \frac{L}{\tfrac{1}{2}a}$$

$$t^2 = \frac{L}{\tfrac{1}{2}\,\tfrac{5}{7}\,\frac{gH}{L}} = \frac{14L^2}{5Hg}$$

which is the desired formula.

Also solved by H. E. McMillin, Washington, Kans., and R. C. Colwell, Beaver Falls, Pa.

115. *Also corrected by R. M. Wylie, Huntington, W. Va., and G. B. Claycomb, Geneseo, Ill.*

WASHINGTON'S SURVEY GETS GOVERNMENT O. K.

Government surveyors, who have just been checking up some of the lines reputed to have been run by George Washington in his days of chain and compass work, have found them good.

About 1751, according to tradition, George Washington, then 19 years old, ran out for Lord Thomas Fairfax the line between what was then to be Augusta and Frederick counties, Virginia, this being only a part of a great deal of surveying which he is said to have been engaged upon at that time. These two counties were separated from what was then Orange county, and the grant to Lord Fairfax was supposed to extend westward to the Pacific ocean. Subsequently these large tracts were further subdivided, so that the "Fairfax line," as it is generally known, runs now between Rockingham and Shenandoah counties, with the original Augusta and Frederick counties to the south and north respectively.

In the organic act for the formation of the two counties, or "parishes" as they were then called, it was required that the line should be a straight one from the head spring of Hedgman river, one of the sources of the Rappahannock, to the head spring of the Potomac.

Since it was required that the line should be straight it was first necessary to get the approximate course by building large bonfires on the intervening high points. Then starting from the top of the Massanutten mountains, the line was run straight away over intervening mountains and rivers toward the northwest.

The Fairfax Stone.

Away off across a part of what is now West Virginia there is a large rock known today as the Fairfax Stone. It is the monument which marks the southwest corner of Garret county, Md., the southeast corner of Preston county, W. Va., and prominent points in the boundaries in two other West Virginia counties. A line from Orange courthouse, coinciding with the Shenandoah and Rockingham county line, passes through this Fairfax stone, which gives the name to a nearby station, Fairfax, on the Western Maryland railroad. It has been assumed that, in running this

line, a high peak northwest of Orange courthouse was the starting point, and that from here it was possible to see a distant peak in the north mountain range over the top of the intervening Massanutten mountain.

Washington, of course, used a simple compass, and his line could not be expected to check absolutely with that obtained by the government surveyors who have retraced his survey, using high-power transits and all the refined and accurate methods which modern instruments allow. Nevertheless, the line was run so carefully in the first place that but little variation has been found in it. Even without instruments it is possible to distinguish the course of the line with surprising distinctness. From the top of Middle Mountain in the Massanutten range, the Shenandoah-Rockingham, or Fairfax, line can be readily followed by means of the boundary fences dating from earliest days, and by the blocks of timber, alternately cleared away or left standing, which come up from either county and stop at the line, like squares in a checkerboard. Then if one turns to the southeast the same demarkations are plain across the valley of the south fork of the Shenandoah, cutting straight through the present Page county, which is made of land formerly in Shenandoah county, belonging to the Fairfax grant, and partly from land formerly in Rockingham. Thus, as far as the eye can see in either direction, this old line shows plainly.

The Washington compass, now to be seen at the United States national museum in the city named for its owner, is presumed to be the same one used in running this line more than 160 years ago.

WASHINGTON'S SURVEY MARKS.

The Fairfax Stone stands as a permanent monument. In addition, there are, throughout that section of the country, various other records of these Washington surveys. For example, a large white oak which stands at the corner of a farm about 1½ miles from Lost City, Hardy county, W. Va., was, according to a persistent story of that section of the country, marked by Washington.

Survey blazes cut into trees, and since grown over, have been cut away, and a count of the annual layers of growth over the old wounds shows them to have been made at the time Washington was surveying. One strange thing about these blazes is that they are several feet higher than those put on trees by woodsmen of today. This fact has given rise to a sort of superstition that Washington, known to have been very tall, was actually a giant. Other authorities have said that Washington did much of his work on horseback, and made his blazes with a long-handled ax from the saddle.

The town of Whitepost, Clarke county, Va., takes its name from a post presumed to have been set by Washington as one of his survey marks. The post, formerly exposed, is now covered by a protecting case which shelters it from the weather, and from the despoiling hand of the vandal tourist.

WHY THE LINE IS RETRACED.

The reason that this old Washington survey line is being retraced is because the federal government is purchasing lands in this neighborhood, in connection with the new Appalachian forests which are being acquired at the headquarters of navigable streams, under the terms of the Weeks law, designed to protect these watersheds from the evils of deforestation. The government requires a clear title before the land can be paid for. In making sure of the titles it is necessary, in many cases, to go back to original royal grants, or to colonial records, and to have recourse to resurveys before the facts of ownership can be indisputably established.—*Forest Service.*

LIVE CHEMISTRY.

By H. R. Smith,
Lake View High School, Chicago.

The following experiments have been submitted without a special request for them. This is a hopeful sign that there are some live chemistry teachers in existence. We have been wishing for a real experiment in soap-making. The following one illustrates a most important function of industrial chemistry in that a waste product is converted to good use. Let us have more of this kind. A real analysis may be done by the student using the one per cent of acetic acid in vinegar. These experiments suggest the converse of the oft repeated question in teaching chemistry, "What manual do you use with the text?" Why not, "What text do you use to help explain laboratory practice?"

An Experiment in the Manufacture of Soap.

By H. A. Webb,
West Tennessee State Normal, Memphis.

If the mothers of our students will save the fat from their skillets (which is often thrown away) for a few days, there will soon be three or four pounds of black, ill-smelling grease available for soap-making. This should first be strained through a cheese-cloth, and solid particles removed.

Procure from the grocery store a few cans of concentrated lye (KOH), one five-cent can being sufficient to convert about three pounds of the ordinary fat obtained from the kitchen. Weigh the fat, and melt it in a tin bucket. Dissolve one can of lye in 150 c.c. of water, and add this amount to every three pounds of fat. Add slowly, with constant stirring. One of two things will happen—either the mixture will become homogeneous, and syrupy, in which case our grandmothers would have poured it out, and made "soft soap," or else, (because the moon was not right!) the mass will "curdle" and look like melted grease. In either case, put in about a handful of salt, stir well, let it cool, and skim off the floating soap with a spoon. If the liquid seems greasy, an insufficient amount of lye was added, and a repetition of the process will form more soap.

The soap which was skimmed off should now be placed in the bucket with a little water, and boiled down, until a little, taken out on a stick, hardens in a few minutes. It is then poured into moulds of match-boxes, or shallow lids, and subsequently cut to the desired shape. The soap formed in this manner (no matter how dark and rancid the fat was) will be of better grade than the average laundry soap, but not as pure as the toilet variety. To further purify the soap, remelt it, with a little water, in the tin bucket, add two or three pints of water, and a handful of salt, stir well, cool, and skim off as before. The soap will usually be snow-white.

Give each student a portion of the soap, and let different varieties be made, as follows:

Colored soap; use vegetable coloring materials, such as are used in ice-cream, frostings, etc.

Medicated soap; stir a weak solution of carbolic acid with the melted soap—use mentholatum, camphor, etc.

Perfumed soap; a dash of nitrobenzene, toilet water, etc.

Scouring soap; stir in some fine sand.

"Beauty soap"; stir in some oatmeal, or corn meal.

If the salt water from which the soap was first skimmed is evaporated

down, the residue taken up in alcohol, and again evaporated after filtration, the syrupy, sweet-tasting glycerine will be obtained.

The teacher must use his discretion as to the amount of chemical theory presented with this process, and whether the reactions of palmitic, oleic, and stearic acids shall be discussed.

Be sure to send one of the best cakes of soap to the principal or president of the school. He will be highly pleased, and will know that the class is doing "fine, practical things."

An Experiment with Two Familiar Hydrocarbons.

By H. A. Webb.

West Tennessee State Normal, Memphis.

In two bottles of equal size, pour five cubic centimeters of gasoline, and of kerosene. After about two minutes, stick a lighted match to the mouth of each. In which is there an explosion? What precautions should be taken around a gasoline stove?

Arrange a water bath by placing a small beaker (about 50 c.c.) inside a larger one, and supporting it by means of corks, cut in halves, inserted between the rims. Pour water in the larger beaker to about one inch in depth—fill the smaller beaker nearly full of kerosene. Pass a thermometer through a cork, and support in such a manner that the bulb is immersed in the kerosene, but not touching the bottom or sides of the beaker. Heat the water until the temperature is about 30° C., then heat carefully, so that the thermometer rises only two or three degrees a minute. About every ten seconds, draw a lighted match across the surface of the kerosene (do not be afraid—it will not catch fire) until finally a temperature is reached at which there is a tiny flash, and an almost inaudible "pop" when the match is touched to the surface. Read the thermometer immediately, it is the flashing point ("flash point") of kerosene.

This temperature, which is in Centigrade degrees, must be converted to Fahrenheit degrees, the scale used in the U. S. To do this, multiply your reading by 9/5, and add 32 degrees.

Most states have laws specifying the minimum flash point of kerosene allowed to be sold in that state. In some of these, the point is 110°. Each state has a number of "coal-oil inspectors," who get fees for testing the kerosene. In many places, these are political offices, not held by scientific men, and are regarded as "soft snaps."

The best and safest grade of oil should have a flash point of about 150° F.

The above experiments will greatly assist in the explanation of the fractional distillation, or "cracking" of crude petroleum.

Per Cent of Acetic Acid in Vinegar.

By Thomas R. Stout,

Menominee, Wis.

Call attention to the standard as fixed by the state and United States laws. Note how easy it is for the dealer to dilute his stock.

Collect samples of the various kinds, cider, spirit, malt, etc., and also of various brands.

Dilute ten cubic centimeters of vinegar to one liter. Take 27.5 cubic centimeters of the diluted sample, add from 3 to 8 drops of a 5 per cent alcoholic solution of phenol phthalein and measure into it from a burette or graduated pipette enough lime water to cause the pink color of the

indicator to persist. The number of cubic centimeters used is the per cent of acetic acid in the vinegar. We use graduated pipettes for this experiment because these are supplied with the desk equipment and we do not find it convenient to supply the burettes.

Leach, who proposes this method, gives the strength of lime water as 1/21.4 Normal. He does not claim absolute accuracy for the method and stipulates that an excess of lime be left in the reagent bottle to insure saturation.

Purpose—To Test Ten Samples of Cheap Penny Candy for Solubility, Starch or Flour and Glucose; Also to Compute the Cost of a Pound of the Candy.

By A. C. Norris,
Rockford, Ill., High School.

Method: (1) Buy ten different kinds of penny candy. Weigh what you get for a cent and then calculate how much it costs you per pound.

(2) Put a piece of the candy in a clean evaporating dish half filled with distilled water and bring to a boil, noting the time it takes for the candy to dissolve. What is the character of the residue? If the solution is highly colored, learn how to test for coal tar dyes. (See page 76, Allyns Applied Chemistry.)

(3) Let some of the liquid in No. 2 get cold, and then add a few drops of iodine solution. While boiling the piece, did it get soft like a piece of macaroni? Why is candy made from flour more injurious than macaroni?

(4) Bring to a boil in an evaporating dish ten c.c. of Febling's solution. When boiling briskly, add about five c.c. of the solution in No. 1. Do you get a test for glucose? Is glucose harmful in candy? Why is it put into candy?

Conclusion: What constitutes a good candy? What ingredients should not be used in candy? What is the cost of the ingredients you have found? What should be a reasonable price for such candy? Sum up your tests and what you have learned.

VARIETIES OF ASTERS.

The herbarium kind of botanist often speaks disparagingly of the gardener's favorites but the latter individual makes everything even by considering all plants growing without cultivation as mere weeds. It is not uncommon for the thoughtless to ask "Is it a flower or a weed?" when some new specimen with handsome flowers is brought to their notice. All cultivated flowering plants must, of course, grow wild somewhere, though in many cases the garden forms have been improved by inducing them to bear differently colored or larger flowers, or more of them. It may astonish many botanists, however, to know that gardeners have no less than ten named varieties of the New England aster *(Aster nova-Angliae)* while the botanical manuals have only one—*rosea*. Among the gardener's creations are plants with deep crimson flowers which quite outclass the pink-flowered form that botanists have thought worth while dignifiying with a name. Many other species of our native asters are cultivated and are regarded by plant lovers as quite as handsome as any other garden flowers. The New York aster *(A. nova-Belgii)* has no less than twenty-six varieties in cultivation, the flowers ranging in color from white to clear blue and deep pink. If ever the species maker gets hold of an up-to-date nurseryman's list what a changing of names and making of new species there will be!—*American Botanist.*

REPORT ON QUESTIONAIRE TO NEBRASKA PHYSICAL SCIENCE TEACHERS, APRIL 1, 1913.

BY J. C. JENSEN,
Nebraska Wesleyan University.

In the June, 1910, issue of *Science* occurred an article by Edwin H. Hall of Harvard University in which were tabulated not only a lot of data concerning standard experiments for the physical laboratory, but what was of much greater significance, an inquiry into the preparation of the teachers themselves. It is not within the province of this report to recite the details of the paper referred to but it is of great import that we note the fact that practically all of those replying to Dr. Hall's questions, including forty college professors and nearly as many high school teachers, all prominent in their field, recommended as the minimum preparation for the high school teacher of physics a baccalaureate degree with a major in the subject and with a general knowledge of chemistry and mathematics including the calculus. There was the usual division on the question as to whether there should be more educational theory and less subject matter, or vice versa, but I believe the requirements as above stated give a fair estimate of the report as a whole.

With this in mind, the Executive Committeee of the Physical Science Section took occasion last spring while attempting to ascertain the opinion of the rank and file of physics and chemistry teachers of the state concerning the next program, to ask some questions which many doubtless considered impertinent. So far as individual replies are concerned, however, all has been held in the strictest confidence. Of the 230 cards sent out only 70 replies were received, some of the latter being incomplete. Cards were sent only to schools on the list accredited by the University of Nebraska. Returns from practically all of the larger schools are on file so it would seem only fair to assume that a report based on the data at hand will be optimistic rather than otherwise.

To refer to the replies directly, we find that in the 71 schools there are 46 college graduates and 26 normal school graduates teaching physics. Deducting 7 who are both college and normal school graduates, we have 65 out of 71 or 91.5 per cent thus trained, a very creditable showing. In chemistry we have 35 college graduates and 20 from the normals. Deducting 6 who hold diplomas from both college and normal school, there are left 49 out of 55 schools offering chemistry or a little more than 90 per cent.

In order to get some idea of the relative preparation of these teachers they were asked to state where their majors and minors wre taken, and if neither of these was physics or chemistry, then the number of credit hours earned in advanced work in these subjects. Of the 65 physics teachers mentioned above, 18 had majors in the subject, 14 minors, and 10 two or more hours of advanced work. This makes a total of 42 or about 65 per cent. The remaining 35 per cent presumably have no preparation beyond their elementary work in the subject. Of the 49 chemistry teachers there were 11 majors, 12 minors and 7 who had taken advanced work, a total of 30 or 61 per cent of the whole. To those of us who are familiar with the attainments of the average high school student, especially in schools where lack of room, apparatus and time on the part of the teacher render laboratory work almost an impossibility, the chances for success of the 35—39 per cent do not appear very bright. It is true that much very good work is done by teachers without advanced preparation, but how much broader the outlook and clearer the vision if the teacher has this higher ground to stand upon.

We all realize that in the smaller schools where one teacher must handle all the science and mathematics, another all the history and language, etc., that the teacher can not well be a specialist in botany, agriculture, geography, physics and mathematics but does it not seem reasonable to require that those preparing for public school positions shall have at least one course of college rank in each subject which he may be required to teach even in a small school of two or three teachers? Furthermore, is it not possible that boards of education might pay a little more attention to the specific thing a candidate can teach, rather than to testimonials of a general character? It must be said here in defense of those employing teachers, however, that candidates who are well prepared for science teaching are very hard to find as compared with those who have equivalent training in language and history. In fact I have never known of a college graduate with adequate science preparation who was long without a position. The dearth of candidates for this kind of teaching is doubtless due to our present system of electives which gives the student an opportunity to evade any subject which we may consider difficult to master or which may have laboratory work attached to limit his freedom to participate in afternoon outings and athletics.

Regarding some other points of the inquiry, brief mention should be made. The usual number of recitations per week is three in both subjects, while the number of hours of laboratory work is a little less than four in each subject, a number of schools reporting two hours. These "hours" are of 45 minutes each as a rule, which leads me to say that judging from my own experience, this is not time enough to do the work thoroughly in either physics or chemistry although it may be as much as would be used on any other subject for the same credit.

In the matter of equipment, we have invoices ranging all the way from $75 to $2,500 in physics and from $50 to $2,000 in chemistry. It may be said in parentheses that the city reporting $75 for physics is one of twelve full grades with a population of at least 3,000 and a full quota of "revenue producing" saloons. This apparatus suffices for a class of twenty and we also learn that the teacher has twenty recitation hours per week and ten hours of laboratory. Several teachers, however, report as much as thirty hours of recitation and ten hours of laboratory weekly.

The reports show that there is practically complete agreement on placing physics in the eleventh grade and chemistry in the twelfth although several strong schools alternate the two with a saving of teachers and a concentration on one subject.

In conclusion, I wish to say that while the teachers did not make possible a complete report, the data submitted is worthy of careful thought and consideration. If one thing stands out more prominently than all others it is that our teachers are very well prepared in a general way but that there are too many, at least among teachers of physics and chemistry, who are working out of their proper sphere, a condition by no means blamable entirely to the teachers themselves.

AN ARITHMETICAL CURIOSITY.

In an old logarithm book I came across the problem, "What is the largest number that we can express by three digits?"

The answer is, of course, $9^{(9^9)}$; it is a number of inconceivable and appalling magnitude, compared with which the huge numbers that we meet with in sidereal astronomy fade into absolute insignificance: 9^9 is 729^3, which is easily found to be 387,420,489. We have to multiply log 9 by this figure in order to obtain log 9^{9^9}. Seven-figure logs are useless; we must employ at least 10-figure ones to get any significant figures in the answer. I had recourse to the 61-figure logs of certain numbers computed by Abraham Sharp, and given in Hutton's tables. From these I find that long 9^{9^9} = 369,693,099.63157, 03587, etc. Hence the number contains 369,693,100 figures. I have found the first 28 of them to be 428, 124, 773, 175, 747, 048, 036, 987, 115, 9. We also know that the two final figures of the number are 89,[1] since odd powers of 9 end successively with 09, 29, 49, 69, 89, 09, etc. A knowledge of 30 figures out of 300 million may seem trifling, but in reality the error involved in taking all the remaining figures as zeros is only one part in a thousand quadrillions. If the number were printed with 16 figures to an inch (about the tightest packing for decent legibility), it would extend over 364.7 miles, or from London to Perth. If printed in a series of large volumes, we might get 14,000 figures to a page, and with 800 pages to the volume it would fill 33 volumes. There are more than twice as many digits in the number as there are letters in the whole of the Encyclopedia Britannica.

To find the largest number suggested by sidereal astronomy I took the following: Both Very and See have expressed the opinion that certain visible objects may be at a distance of a million light years; I imagine a solid sphere of platinum of this radius, and find how many electrons it contains. From Duncan's *The New Knowledge,* p. 65, I find that the log of the number of electrons in a cubic centimeter of water is 16.469. Taking the density of platinum as 21.5, the log of the number of electrons in a cubic inch of it is 19.016, and the log of the volume of the huge sphere in cubic inches is 19.016, and the log of the volume of the huge sphere in cubic inches is 71.3362. Whence the log of the number of electrons it contains is 90.352, and the corresponding number is 225 followed by 88 zeros. At 16 figures to the inch this would take 5⅝ inches, just the width of the page of our Journal.

It is interesting to note that the number of electrons in the body of each human being would suffice to change about 21 of the 91 figures.

To find the radius of a sphere of platinum that would contain 9^{9^9} electrons, we must multiply our million-light year radius by a number whose log is 123,231,003.093, i. e., the multiplier is 1239 followed by 123,231,000 zeros. In fact, that gigantic sphere would exceed the million-light-year sphere in a far higher ratio than that exceeds the size of one electron.[2] Hence we may take it as morally certain that we can write with three digits a number vastly exceeding the number of electrons in the whole of creation, which is a somewhat startling fact. Indeed even the number 4^{4^4} (which is 13407813 followed by 147 other figures) probably exceeds the number of electrons in creation. At least it equals the number of electrons in a solid platinum sphere that exceeds the million-light-year sphere in the same proportion that that exceeds a sphere 206 inches.—*A. C. D. Crommelin* in *Journal of the Brit. Astron Assoc.*, May 1913.

ARTICLES IN CURRENT PERIODICALS.

American Botanist for February; *Joliet, Ill.; $1.00 per year:* "The American Lotus," Chas. O. Chambers; "Undraped Trees," W. W. Bailey; "Xeraphytes," Willard N. Clute.

American Forestry for March; *Washington, D. C.; $2.00 per year, 20 cents a copy:* "Forestry on the Country Estate" (with 7 illustrations), Warren H. Miller; "A Woman as Forest Fire Lookout" (with 8 illustrations); "The Place of a Forest Supervisor in the Community" (with 2 illustrations), Paul G. Redington; "Business Management of Woodlots" (with 10 illustrations), R. Rosenbluth; "Utilization at German Sawmills" (with 7 illustrations), Nelson C. Brown; "State Forests as Bird Sanctuaries" (with 12 illustrations), William P. Wharton.

American Journal of Botany for February; *Brooklyn Botanic Garden, Brooklyn, N. Y.; $4.00 per year, 50 cents a copy:* "On the Mycorhizas of Forest Trees," W. B. McDougall; "Notes on the Calculation of the Osmotic Pressure of Expressed Vegetable Saps," J. Arthur Harris and Ross Aiken Gortner; "The Pyrenoid of Anthoceros," F. McAllister.

American Mathematical Monthly for March; *5548 Kenwood Ave., Chicago, Ill.; $2.00 per year:* "Optical Interpretations in Higher Geodesy," Wm. H. Roever; "A Theorem in the Modern Plane Geometry of the Abridged Notation," Robert E. Bruce; "A Note on Synthetic Projective Geometry," Lao G. Simons.

American Naturalist for April; *Garrison, N. Y.; $4.00 per year, 40 cents a copy:* "The Origin of X Capsella Bursa-pastoris arachnoidea," Dr. Henri Hus; "Biology of the Thysanoptera," II, Dr. A. Franklin Shull; "Shorter Articles and Discussion: Barriers as to Distribution as Regards Birds and Mammals," Joseph Grinnell.

Condor for March-April; *Hollywood, Cal.; $1.50 per year, 30 cents a copy:* "History of a Pair of Pacific Horned Owls" (with 8 photos), J. B. Dixon; "Destruction of Birds in California by Fumigation of Trees," A. Brazier Howell; "An Asionine Ruse," William Leon Dawson; "Some Discoveries in the Forest at Fyffe" (with 8 photos), Milton S. Ray; "Birds of Sitka and Vicinity, Southeastern Alaska" (with 1 photo by E. W. Merrill), George Willett.

Educational Psychology, for February; *Warwick and York, Baltimore, Md.; $2.50 per year, 30 cents a copy:* "Some Results of Practice in Addition Under School Conditions," H. H. Hahn and E. L. Thorndike; "The Relation of Length of Material to Time Taken for Learning, and the Optimum Distribution of Time," Part II, Darwin Oliver Lyon.

Journal of Geography for April; *Madison, Wis.; $1.00 per year, 15 cents a copy:* "The Wisconsin Number," by many authors. A very interesting number. Send for a copy.

National Geographic Magazine for March; *Washington, D. C.; $2.50 per year, 25 cents a copy:* Twenty-one pages of four-color work. "Village Life in the Holy Land" (with 27 illustrations), John D. Whiting; "Encouraging Birds Around the Home" (with 36 illustrations), Frederick H. Kennard; "Redeeming the Tropics," William J. Showalter; "Scenes in the Byways of Southern Mexico."

Nature-Study Review for March; *Ithaca, N. Y.; $1.00 per year, 15 cents a copy:* "The Beginning of Star Study," II, Anna B. Comstock; "Preparing Normal Students to Teach About Birds," Gilbert H. Trafton; "Outdoor Equipment," James G. Needham; "The Cape May Summer School," Laura E. Woodward; "Hibernation Among Plants and Animals," Harold B. Shinn; "Some Insect Studies," Alice Jean Patterson.

Photo-Era for April; *383 Boylston Street, Boston; $1.50 per year, 15 cents a copy:* "Camera-Work in Florida" (illustrations by the Author), Julian A. Dimock; "The Value of a Snapshot," A. H. Beardsley; "Spring-Landscapes as Camera-Subjects," William S. Davis; "The Choice and Use of a Miniature-Camera" Part I, C. H. Claudy.

Popular Astronomy for April; *Northfield, Minn.; $3.50 per year, 35 cents a copy:* "The Problem of Three Bodies," F. R. Moulton; "The Moons of Mars," Charles Nevers Holmes; "Variable Star Observing," H. C. Bancroft, Jr.; "Observing Mars," Gilbert Lanham; "Monthly Report on Mars," No. 4, Wm. H. Pickering.

Popular Science Monthly for April; *Garrison, N. Y.; $3.00 per year, 30 cents a copy:* "Fresh Air," Frederic S. Lee; "Nature Play," Charles Lincoln Edwards; "Recent Developments in Weights and Measures in the United States," Louis A. Fischer; "The Struggle for Equality in the United States," Charles F. Emerick; "Eugenics and Euthenics," Maynard M. Metcalf; "The Psychological Limit of Eugenics," Herbert Adolphus Miller; "The Racial Origin of Successful Americans," Dr. Frederick Adams Woods; "Darwin and Wallace on Sexual Selection and Warning Coloration," F. H. Pike.

Psychological Clinic, for March; *Woodland Avenue and 36th St., Philadelphia; $1.50 per year, 20 cents a copy:* "The Montessori Method," Lightner Witmer; "The Artistic Value of the Montessori Geometrical Insects," Harriet Sayre; "Incorrigibility Due to Mismanagement and Misunderstanding," Claiborne Catlin.

Zeitschrift für den Physikalischen und Chemischen Unterricht for January; *in Berlin W. 9, Link-Sts. 23/24; 6 numbers, $2.88 M. 12 per year:* "Schülerübungen aus dem Gebiete der Elektrostatik," E. Grimsehl; "Physik und philosophische Propädeutik," O. Pommer; "Eine statische Methode zur Bestimmung der Direktionskraft eines Magneten," Teege; "Die Schaukel und das zweite Keplersche Gesetz," A-Hartwich; "Das Verhalten der Metalle, insbesondere des Kupfers zu verdünnten Säuren," J. Richard.

Zeitschrift für Mathematischen und Naturwissenschaftlichen Unterricht Aller Schulgattungen for March; *B. G. Teubner, Leipzig, Germany; 12 numbers, M.12.—:* "Die Einführung der Elemente der Differential—und Integralrechnung in die höheren Schulen," Oberlehrer Dr. W. Lietzmann; "Elektronen-Dynamik," Prof. Dr. C. Déguisne; "Ein neuer Beweis des Eulerschen Satzes," Prof. Dr. Ernst Müller; "Bemerkung zu: 'Eine Maximalaufgabe aus der darstellenden Geometrie,' Jg. 42, S. 584-5," W. Weber; "Eine einfache Ableitung des Pythagoreischen Lehrsatzes aus dem Satz von den inhaltsgleichen Parallelogrammen," H. Deutsch; "Ueber eine Lotkonstruktion," W. Tschuppik.

THE STATUS OF THE BOUILLON CUBE.

Advertising literature in which catch-phrase display-lines form a conspicuous feature shows the novel expression "bouillon cubes" among the more recent innovations. The thinking part of the purchasing public have by this time been educated into an appreciation of the limitations of extract of meat as a source of nourishment of the human body. There was a day when beef extract was looked on as embodying the very essence of nutrition. The fact is that it is a flavoring agent and, in the words of a well-known writer on dietetics, "its proper place is in the kitchen and not by the bedside." However widely this fact may deserve appreciation and even seem to receive it at present, the American public is a gullible one. From the claim that extract of meat—to quote some actual instances of misbranding—is "a concentrated food that represents the nourishing constituents of fresh beef," or "a combination of all the strengthening and stimulating properties of prime lean beef," or "the most perfect form of concentrated food known," it has been a short step to another suggestive type of advertising. Now it is to the category of the "brain-fag" relievers that the extract of meat in its up-to-date guise of bouillon cubes has been consigned by the present-day exploiter. Undue claims of nutritive superiority are no longer made; but the meat extractions have joined the brigade of ready-relief specifics which are intended to enable the jaded worker to finish his day's task. At any rate the rôle of the bouillon as stimulant alone is implicitly recognized in this latest enterprise.

Without entering into the physiologic or dietetic merits of the propaganda of beef-tea drinking. *The Journal of the American Medical Association* calls attention to some fallacies involved in the use of bouillon cubes and points out some unexpected features of their composition. Common salt is the foremost constituent, contributing from 49 to 72 per cent of the total weight of the cubes of ten leading brands manufactured in the United States and Germany last year. The amount of real meat extract present ranged from 8 per cent in the poorest to only 28 per cent in the best brands marketed. It is true that most of these cubes have no advertised claim to be concentrated beef broth or essence. Many persons, however, believe them to be so, little realizing that cubes which contain about two-thirds salt and never more than one-third meat extract are an expensive form of securing the flavor and other virtues of the latter.

Home-made meat broth or meat and vegetable soups contain more meat extratives and real nutrients than the commercial preparations, and they are cheaper than the bouillon or soups prepared from commercial cubes, extracts or juices. This fact need not, however, condemn the popularity of a harmless ready-to-use expedient in the hasty and convenient preparation of a cup of palatable bouillon. One might as well argue that the nutritious ready-to-eat cereals are to be rejected because they are more expensive, and, in the taste of many, more palatable than the old-fashioned oatmeal which requires a somewhat laborious culinary treatment. The public should be educated to know precisely what is involved when claims pertaining to diet as well as to drugs are made to attract a purchaser. They can then intelligently count the cost, and balance convenience and elegance against personal effort and economy.

WHAT MAKES PEOPLE BLIND.

Did you ever stop to think of the one hundred thousand blind people in the United States, and what caused their misfortune? Did it ever occur to you that about thirty thousand of these unfortunates are unnecessarily blind? Do you know that about twelve thousand of these are children who are blind because of the unfaithfulness of either the father or the mother? Are you aware that twelve thousand people are groping their way about in darkness due to injuries which in most instances could have been avoided by the installation in factories of proper safety devices? Twenty-five hundred of them are deprived from a livelihood because of granular lids, which is preventable by the application of proper remedies. Two thousand are deprived of their sight because of Fourth of July accidents. Fifteen hundred will never again see the light of day because of various causes, such as the drinking or absorbing of wood alcohol and the neglect of proper treatment of certain eye affections. If we look at these figures calmly, they are amazing. We hardly believe that thirty thousand human beings are shut out from earning a livelihood, who might now be employed, self-supporting and productive of several million dollars' worth of labor, if preventive measures had been employed in their cases. We are a long-suffering people, but how much longer must we keep our eyes closed to the fact that if the doctor or midwife had dropped a 1 per cent solution of nitrate of silver into the eyes of the new-born babe, six thousand pairs of eyes would have been saved from the dreadful effects of gonorrheal ophthalmia. If the twelve thousand now sightless from injury had been employed in factories where safety devices were installed they would be producers instead of dependents. Granular lids or trachoma is amenable to treatment, yet twenty-five hundred persons were allowed to become blind from this cause. It must be a

happy thought to all of us to know that the past two years have shown a marked diminution in the number of injuries from Fourth of July accidents. The use of wood alcohol, working in rooms where it is used or drinking "power-house whisky" or some of the various soft drinks containing wood alcohol, has caused a large number of persons to become totally blind. There will always be a certain number of cases of blindness, which cannot be avoided, but it is appalling to think that the sight of thirty thousand of those now blind could have been preserved. How shall we limit blindness in the future? By insisting that our children's eyes shall have proper care. By compelling our factories to install safety devices. By medical inspection of schools. The child sitting next to your child may have diphtheria and convey it to your child's eyes. By demanding a safe and sane Fourth of July in your own town. By abolishing the roller towel and by establishing such other hygienic measures as will tend to keep us healthy and free from disease.

A MATHEMATICS SOCIETY IN A NORMAL SCHOOL.

BY G. H. JAMISON,
State Normal School, Kirksville, Mo.

Our school has many students preparing to teach mathematics in the high schools of the state. They study such subjects as analytic geometry, calculus, history of mathematics, and theory of equations. With students of such maturity as is found in these classes, a mathematics society was organized last year. Membership was thrown open to any student who expected to teach any branch of mathematics. The society met once every two weeks with an average attendance of about fifty-five for the year. The purpose of the society is to have discussions and reports on various problems of teaching which the live teacher of mathematics meets. On our programs are found such topics as these: "The Uses of the Newspaper and Magazine in the Teaching of Arithmetic," "Graphical Representation in Arithmetic," "The Presentation of Percentage," "How I Continued My Study of Mathematics while Teaching in Rural Schools," "Stocks and Bonds."

It is wholly a student organization except that one of the faculty members works with two students on a program committee. We feel that the society has given large help to the students. They come, they enter into the discussions, they give reports, and they ask questions. For these reasons, the society will continue to exist this year.

INDIANA ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

The Nineteenth Annual Meeting of the Indiana Association of Science and Mathematics Teachers was held Friday and Saturday, March 6 and 7, in the city of Indianapolis.

The first meeting was held Friday afternoon in Caleb Mills Hall at Shortridge High School with Everett W. Owen presiding. Prof. George Buck, Principal of Shortridge High School, welcomed the association to the city. The response was then given by Mr. Owen, the president. The Shortridge Musical Organizations under the direction of Edward Bailey Burge, director of music in the Indianapolis schools, gave an excellent half hour musical program. After a short recess Mr. H. E. Jordan, Superintendent of Filtration, Indianapolis Water Company, gave a very practical and instructive illustrated lecture on "How the Water Supply of a Great City is Safeguarded."

The evening session was held in the Teachers' Room, Shortridge High School, at 7:45 o'clock. The president appointed committees as follows:

Committee on Nominations.

Edwin Morrison, Chairman, Richmond, Ind.
Jacob P. Young, Huntington, Indiana.
Claude Kitch, Indianapolis, Ind.

Auditing Committee.

H. H. Radcliffe, Chairman, Connersville, Ind.
T. H. Allen, New Albany, Ind.
B. D. Neff, Indianapolis, Ind.

Dr. Fernandus Payne, Zoölogy Department, Indiana University, gave a very interesting lecture on "The Part the Cell Plays in Heredity." By the aid of numerous charts Dr. Payne showed the results of Mendels Law of Heredity and its relation to the chromosomes in the development of the cell.

The general business meeting was held in Teachers' Room, Shortridge High School, Saturday morning at 8:30 o'clock. The report of the Secretary-Treasurer was read and adopted and the chairman of the auditing committee reported the Treasurer's accounts correct. The report of the committee appointed at the last general assembly on revision of the constitution was then called for. This report was read by the chairman, Dr. J. C. Naylor, De Pauw University, Greencastle. After a brief discussion the report was adopted. The chairman of the nominating committee reported nominations as follows:

President, Frank B. Wade, Indianapolis, Ind.
Vice President, Benjamin W. Kelly, Richmond, Ind.
Secretary-Treasurer, Ernest S. Tillman, Hammond, Ind.
Chairman of Executive Committee, Wm. R. Hardman, Anderson, Ind.
Member of Executive Committee, Martha I. Ivins, Muncie, Ind.

The report of the committee was adopted and the officers declared elected. The general assembly now discussed the place of meeting for the coming year and voted to meet in the city of Indianapolis. The assembly remained in joint session to hear a report on "The Progress of the Committee of the N. E. A. on the Reorganization of the Science Courses in High School" by Dr. John G. Coulter, Bloomnigton, Illinois. The meeeting then adjourned.

Sectional meetings were held as follows:

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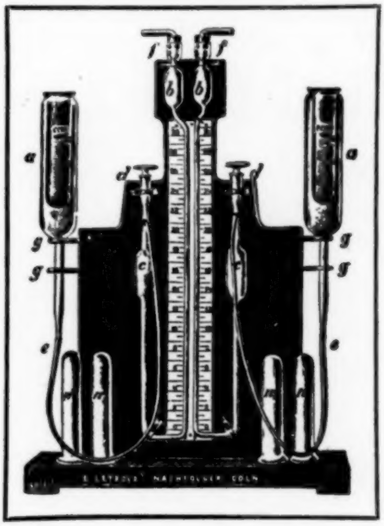

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Physics and Chemistry Sections.

Byron D. Neff, Chairman, Manual Training High School.

Chas. H. Skinner, Secretary, De Pauw University.

Mr. H. M. Ibison, Marion H. S., gave an interesting paper on the subject "Relating H. S. Physics to the Daily Life of the Pupil." His paper was practical and showed that physics could be closely related to daily life without impairing the teaching of fundamentals. Messrs. John H. McClellan and Earl R. Glenn of the Gary schools each gave an illustrated paper on "Physics in the Grades Below the High School." Both were commended on their investigation. The section heard the reports of the Physics and Chemistry Committees on the "Status of Physics and Chemistry in the High Schools of the State." Mr. Weyant, the chairman of the physics division, recommended that there be a sort of framework common to all the high schools of the state. Mr. Ackney at the request of the chairman outlined very briefly the work offered at the Manual Training High Schools. Also, by request Mr. Blair outlined briefly the work offered by the Shortridge High School in electrical engineering. Prof. Morrison completed the report of the committee with a paper on the attitude of college men towards the work in the high school science. In the discussion Dr. Foley said that what the college wanted was not the student who learned the most physics in high school, but the student who had learned to think. Mr. C. A. Vallance, chairman of the Chemistry Committee, gave the report for that division. Owing to lack of time, the discussion was deferred until another meeting.

Mathematics Section.

Martha I. Ivins, Chairman, Muncie High School.

Claude Kitch, Secretary, Manual Training High School.

Wm. R. Hardman, Anderson High School, read a paper on the subject, "High School Mathematics and Vocational Education." Miss Mary S. Paxton, Bloomington High School, gave a paper on "The Laboratory Method in Mathematics." Edwin C. Dodson read a paper on the subject, "One Period per Week for Supervised Study in Mathematics." All these papers were freely discussed and the section reluctantly adjourned on account of the lateness of the hour.

Biology Section.

Chas. E. Montgomery, Chairman, Bloomington High School.

Dr. L. J. Rettger, Terre Haute Normal School, gave a very interesting lecture on the subject, "Some Recent Ergebnisse in Physiology." Mr. C. H. Baldwin, State Entomologist, gave a lecture on "Some Phases of Practical Zoölogy." Mr. Baldwin urged coöperation of schools with his office as the best method of increasing the efficiency of the work, throughout the state. Miss Elizabeth Rawls, Shortridge High School, read an excellent paper on "Botany for City High Schools." These papers also aroused lengthy discussions.

The attendance was not as large as last year but it was the opinion of all present that the meeting was by far the best ever held in recent years. For the benefit of those unable to attend, we hope to have most of the papers published in this magazine during the year.

Ernest S. Tillman, *Sec.-Treasurer,*
Hammond, Indiana.

AGRICULTURAL EDUCATION.

A New Section of the Central Association of Science and Mathematics Teachers.

At the Des Moines meeting of the C. A. S. and M. T. it was voted to establish a separate section for high school teachers and others interested in secondary instruction in agriculture. Since there were no section officers to supervise the election of officers for the following year, it was decided that the president of the association should appoint a committee on program for the first meeting to be held in Chicago on November 27 and 28, 1914. It is understood that this committee will assume charge of the first year's meetings of the section and see that officers are selected for the ensuing year's work. Accordingly the president has appointed the following program committee:

Chairman, A. W. Nolan, Agricultural Extension, Urbana, Illinois.
K. L. Hatch, Agricultural Education, Madison, Wisconsin.
George D. Works, Agricultural Education, Minneapolis, Minnesota.
W. H. French, Agricultural Education, Lansing, Michigan.
I. A. Madden, Agricultural, Normal, Illinois.

The program committee already has part of its speakers promised, and the outlook is good for an especially attractive program. Part or all of the following important questions will be discussed: (1) The Course of Study in Secondary Agriculture; (2) Extension Work in Secondary Agriculture; (3) Use of Land in Connection with School Agriculture; (4) Relation of the High School Biological and Physical Sciences to Agriculture; (5) Should Emphasis Be Placed Upon a Two-Year High School Vocational Course in Agriculture, or upon a Longer and More General Course, or upon a Course leading to College Work?

There is probably no subject beside agriculture which includes wider variations in what is being done. Everywhere the teachers of this subject are asking for guidance. The field is so full of possibilities and is so vital that the very opportunities which give such great promise may lead to chaos in school practice. With the coöperation of the program committee, each member of which is recognized as a student of agricultural education, an excellent program is assured. Every high school teacher of agriculture within the territory of the Central Association should join this new section. Agricultural education is in the stage where many questions must be asked, but few positive answers may be given. It is suggested that each teacher write to some member of the program committee, stating his questions, his greatest difficulties, and his successes. This will make it possible to direct the discussions in ways that are most helpful. By all means, plan to attend the section meetings on November 27 and 28, and do what you can to allow the section meeting to serve as a clearing house of ideas upon the present tendencies and present needs of agricultural education in high schools.

BOOKS RECEIVED.

Qualititative Chemical Analysis, by Anton Vorisek, Columbia University. Pages x+226. 16.5x24.5 cm. Cloth. 1914. $2.00. P. Blakiston's Son & Co., Philadelphia.

Elementary Practical Mechanics, by J. M. Jameson, Girard College, Philadelphia. Pages xii+321. 13.5x19 cm. Cloth. 1914. John Wiley & Sons, New York.

Mechanics for Builders, by Edward L. Bates and Frederick Charlesworth. Pages vi+201. 12.5x18.5. Cloth. 1914. Longmans, Green & Company, New York.

Play and Recreation, by Henry S. Curtis. Pages xvi-+265. 13.5x20. Cloth. 1914. $1.25. Ginn & Company, Boston.

Architectural Drafting, by A. B. Greenberg, and Charles B. Howe. Pages viii+110. 28x21 cm. Cloth. 1914. John Wiley & Sons, New York.

Cleveland Public Schools, Annual Report, by the Superintendent, Harriet L. Keeler. Pages xi+107. 15x21 cm. Board of Education, Cleveland.

BOOK REVIEWS.

Pathogenic Micro-Organisms, a text-book of Microbiology for Physicians and Students of Medicine; by Ward J. McNeal, Ph. D. M. D., Professor of Bacteriology in the New York Post-Graduate Medical School and Hospital, New York. Based upon Williams' Bacteriology with 213 illustrations. 20x14.5x2.5 cm. Pages xxi+462. 1914. $2.25 net. P. Blakiston's Son & Co., Philadelphia.

A complete revision, one might almost say a rewriting, of Williams' "Manual of Bacteriology." While intended primarily for physicians and students of medicine, this book might well find a place as a reference book in the library of every secondary school science department. A careful perusal of such parts of the subject matter as the reviewer's experience entitles him to pass upon indicates a high degree of accuracy as to matters of established fact and that a careful and conservative presentation of matters which are still in doubt has been given. Considerable new material has been added especially in regard to parasitic protozoa. F. B. W.

The Examination of School Children, by William H. Pyle, University of Missouri. Pages v+70. 12.5x19.5 cm. Cloth. 1913. 50 cents. The Macmillan Company, New York.

This little book will enable the teacher to get a better understanding of her pupils, first by convincing her of its importance and then creating a desire to make a thorough scientific study of each child. It gives directions, in convenient form, how to properly examine school children. Tables of names for various ages are also given. For grammar and high school work of this nature, it is a most excellent help, and all teachers should possess a copy. C. H. S.

A. Mendelejeff's table in the form of a wall chart, 35x35 cm., on cardboard was received from Prof. J. N. Swan of Monmouth College. The amphoteric elements are underscored on the chart. Elements whose positions are still uncertain are omitted. While no price was indicated copies of this chart can doubtless be had of Prof. Swan at a nominal figure. F. B. W.

Field Manual of Trees, by J. H. Schaffner, Professor of Botany, Ohio State University. Published by R. G. Adams & Co., Columbus, Ohio, 1914.

This manual, consisting of 154 pages of a size that will easily slip into one's pocket, is bound with flexible cover, and is one of the most convenient in form that has been published. In its content it is excellent. It includes all of the trees of the eastern part of the United States and north of the southern boundary of Virginia, Kentucky, and Missouri. The key is extremely simple and selects the characteristic features of the trees in such a way that an amateur may very readily learn to identify the trees of his locality. The excellent glossary is of great assistance to one who is not an advanced student of botanical science. The winter characteristics are given chief consideration, thus making it possible for one to use the manual at any time of the year. O. W. C.

Chemistry and Its Relation to Daily Life, a text-book for students of agriculture and home economics in secondary schools, by Louis Kahlenberg, Professor of Chemistry and Director of the Course in Chemistry in the University of Wisconsin and Edwin B. Hart, Professor of Agricultural Chemistry and Chemist to the Agricultural Experiment Station in the University of Wisconsin. Pages vii+393. 19.5x13.5x 3 cm. 1913. $1.15. The Macmillan Company, New York.

Information seems to be the watchword in this text. It stands out prominently throughout the book. The first third of the volume attempts to set forth briefly the fundamentals of the subject, but even in this part the material is furnished to the pupil ready made and he is not permitted to go behind the scenes to see for himself how the information may be obtained from nature. The questions at the ends of the chapters seem to demand "Have you stowed away this mass of information successfully?"

Chemical theory is frankly neglected. Much stress is laid upon what are called practical applications. In short the book is admirably built to satisfy the present popular clamor for what the public considers the immediately useful. If that type of work is believed in this book is as well suited to it as any we have seen. F. B. W.

Syllabus of Plane Geometry, by Robert R. Goff, B. M. C. Durfee High School, Fall River, Mass. Pages 20. 15x22 cm. 1914. Paper. Published by the author.

While the report of the Committee of Fifteen on the Geometry Syllabus is followed somewhat closely, the arrangement of theorems is made on a new plan. Theorems are grouped according to their conclusions. This is shown by the following titles of chapters: First principles, congruent triangles, equality from congruent triangles, inequality, parallel lines, equality from parallel lines, angle-sums, loci, first principles and tangents, equality of arcs, inequality of arcs, measure of angles, property of parallel lines, property of similar triangles, linear measurement of triangles, similar polygons and circles, and areas of simple figures.

Each set of theorems is followed by a summary and from ten to twenty exercises. Teachers who wish to use the syllabus method will find this pamphlet very useful. H. E. C.

Essentials of Physics, by George A. Hoadley, Professor of Physics in Swarthmore College. Pages 536. 12.5 x18.5 cm. Cloth. 1913. American Book Company, New York.

This attractive text is apparently an enlarged revision of the author's *Elements of Physics,* issued in 1908. It contains eleven chapters, divided into 32 sub-topics. At the end of nearly every sub-topic is a list of well-selected questions and also one of numerical problems. Answers to the numerical problems are to be found in the appendix. The latter also contains a table of "conversion factors" and a list of the 62 formulas employed in the text.

In regard to the order of topics, mechanics of solids precedes that of liquids and gases, sound precedes heat and light follows electricity.

The text is well printed on good paper and shows the tool marks of good workmanship in everything that indicates a well-finished product.

It is unusually well supplied with illustrations, containing 557, of which 25 are full page half-tones. Some of the latter, "show the advances that have been made in well known machines," others represent some of the latest triumphs of mechanical and electrical engineering. No portraits of men prominent in the history of physics are shown.

The book deserves the careful consideration of those contemplating the adoption of a new text in physics. W. E. T.

Algebra, Book I, by Fletcher Durell, Ph. D., Head of the Mathematical Department of the Lawrenceville School. Pages 392. 13x19 cm. 1914. Price, $1.00. Charles E. Merrill Company, New York.

For the convenience of a two book course the author's *School Algebra,* which was reviewed in a recent number has been divided into two parts. Book I contains the work usually given in the first year of high school.

H. E. C.